

JANUARY 21, 1981

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EDN

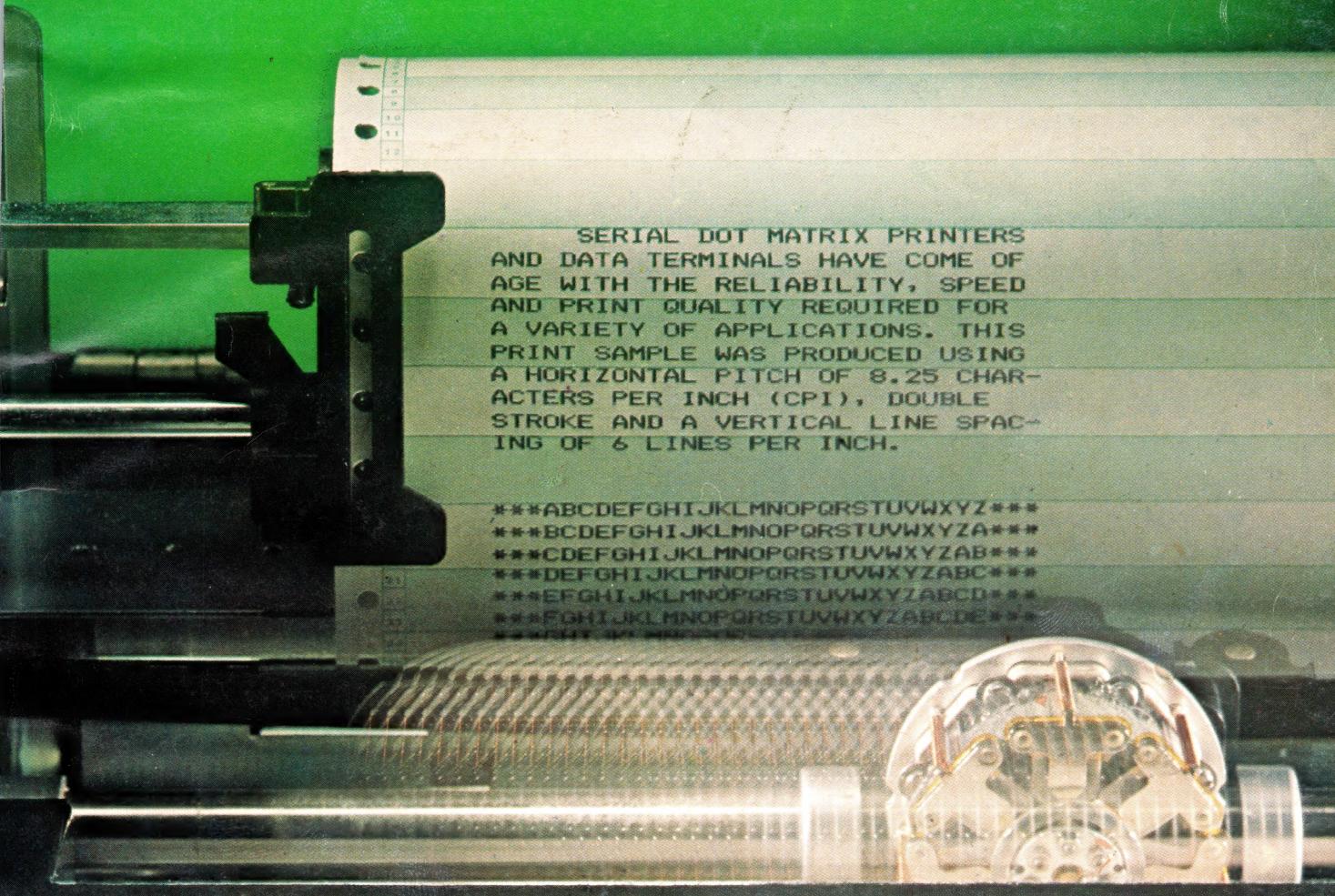
EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS

Second annual
Programmable-Memory
Directory

Accurate autocal tester
measures low resistances

Error-hunting program
evaluates memory reliability

Dot-matrix printers approach letter-quality output



SERIAL DOT MATRIX PRINTERS AND DATA TERMINALS HAVE COME OF AGE WITH THE RELIABILITY, SPEED AND PRINT QUALITY REQUIRED FOR A VARIETY OF APPLICATIONS. THIS PRINT SAMPLE WAS PRODUCED USING A HORIZONTAL PITCH OF 8.25 CHARACTERS PER INCH (CPI), DOUBLE STROKE AND A VERTICAL LINE SPACING OF 6 LINES PER INCH.

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***ABCDEFGHIJKLMNPQRSTUVWXYZ***  
***BCDEFGHIJKLMNPQRSTUVWXYZA***  
***CDEFGHIJKLMNPQRSTUVWXYZAB***  
***DEFGHIJKLMNPQRSTUVWXYZABC***  
***EFGHIJKLMNPQRSTUVWXYZABCD***  
***FGHIJKLMNPQRSTUVWXYZABCDE***  
***GHIJKLMNPQRSTUVWXYZABCDE***
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Texas Instruments
OMNI 800
820 KSR TERMINAL

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RESET

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It started as a racehorse. It's becoming a workhorse. Because our Sentry® Series 20 LSI test system is adding the capabilities to run more devices in more technologies. And still grow to meet the future head on.

Modularity makes it work. Configure Series 20 to meet a variety of duties. Characterization. Production testing. Incoming inspection. Or a combination. Its designed-in expandability lets you get exactly what you need. When you need it.

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If you're working with CMOS or



PMOS devices, try our new high voltage test head. You can run 28V at 5MHz, 16V at 15MHz or 10V at 20MHz.

And if high speeds or high pin counts are in your future, Series 20 should be on your line. Modular bays let you expand your system with surprising ease.

Series 20 has an improved software system. You can convert Sentry VII and VIII programs to Series 20 format, usually within minutes. And you can test devices

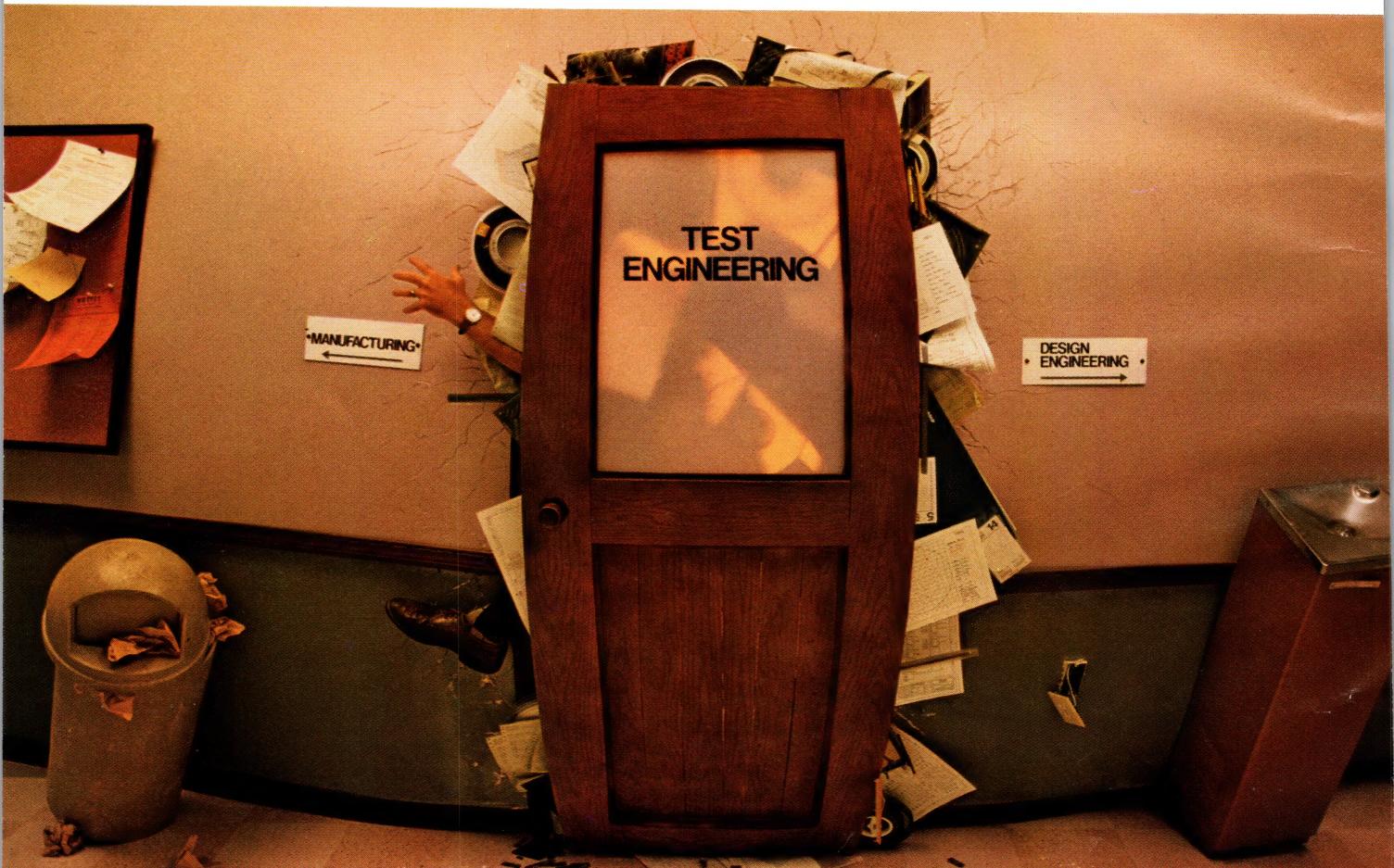
more thoroughly and efficiently. Getting better data while saving valuable time.

So give our workhorse a workout. It's backed by the industry's largest service and support group. Call us at (408) 998-0123 for more information. Or write Fairchild Test Systems Group, 1725 Technology Drive, San Jose, California 95110. You'll see how Series 20 will grow on you.

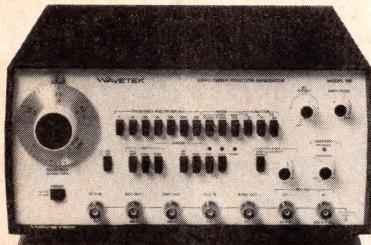
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Wavetek Model 189 sells for \$695.* Yet it has digital storage of sweep settings just like the expensive instruments.

Turn the dial to the desired low frequency (down to 4 mHz) and push START. Then turn the

dial to the high frequency (up to 4 MHz within sweep limits) and push STOP. Both frequencies are stored in memory, so the dial is now available for setting the marker frequency.

Other controls set sweep rates from 100 microseconds to 120 seconds, hold or reset sweeps, and set output level (up to 20V). As a function generator, Model 189 gives precision sine, square and triangle waveforms from 4 mHz

**Circle no. 2 for demonstration
Circle no. 3 for literature**

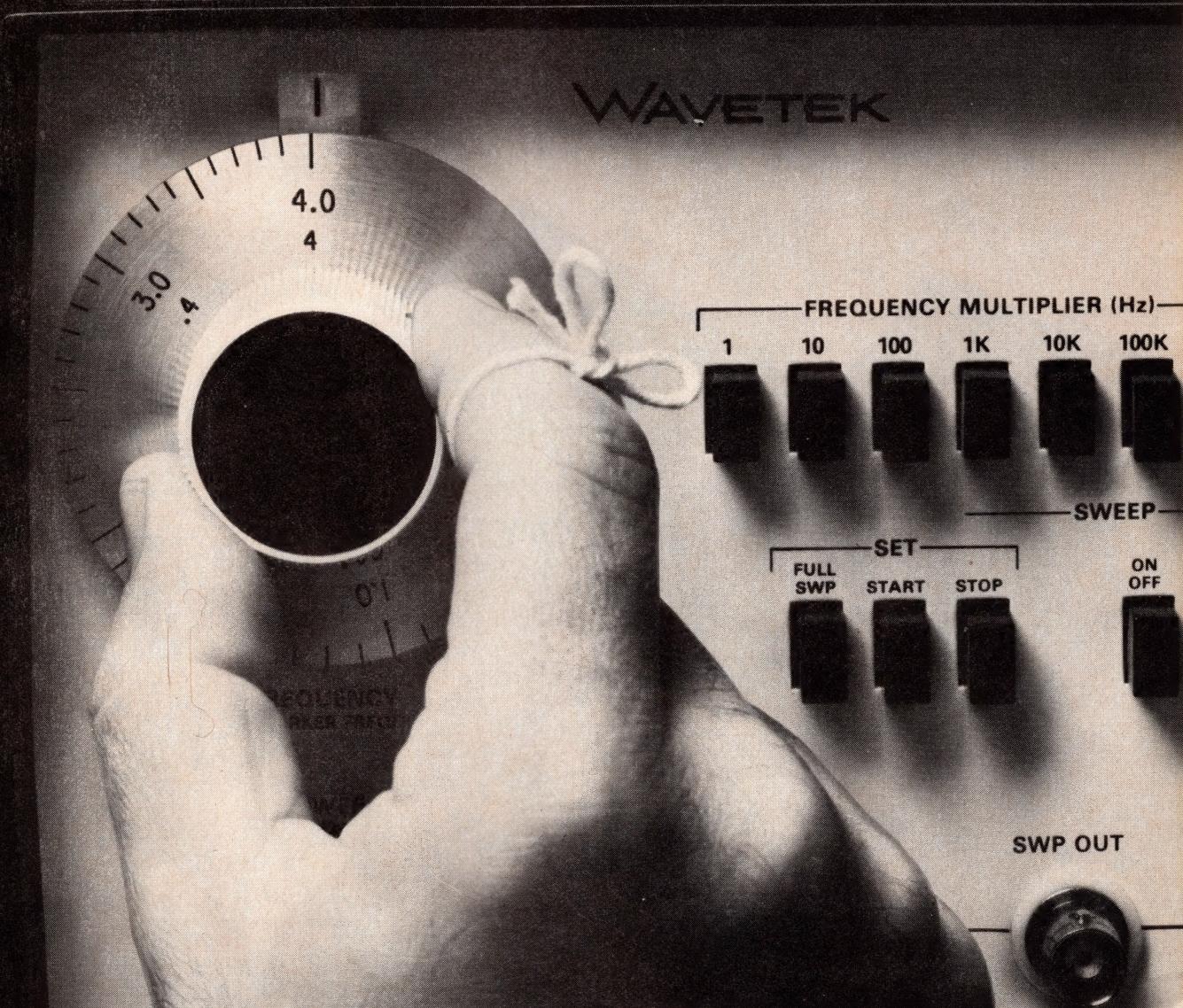
to 4 MHz in continuous, triggered or gated modes.

So if you're looking for an inexpensive sweep/function generator that handles precision sweeping assignments, remember the Wavetek Model 189. Better yet, call or write us today. Wavetek San Diego, P.O. Box 651, 9045 Balboa Avenue, San Diego, CA 92112. Tel (714) 279-2200; TWX 910-335-2007.

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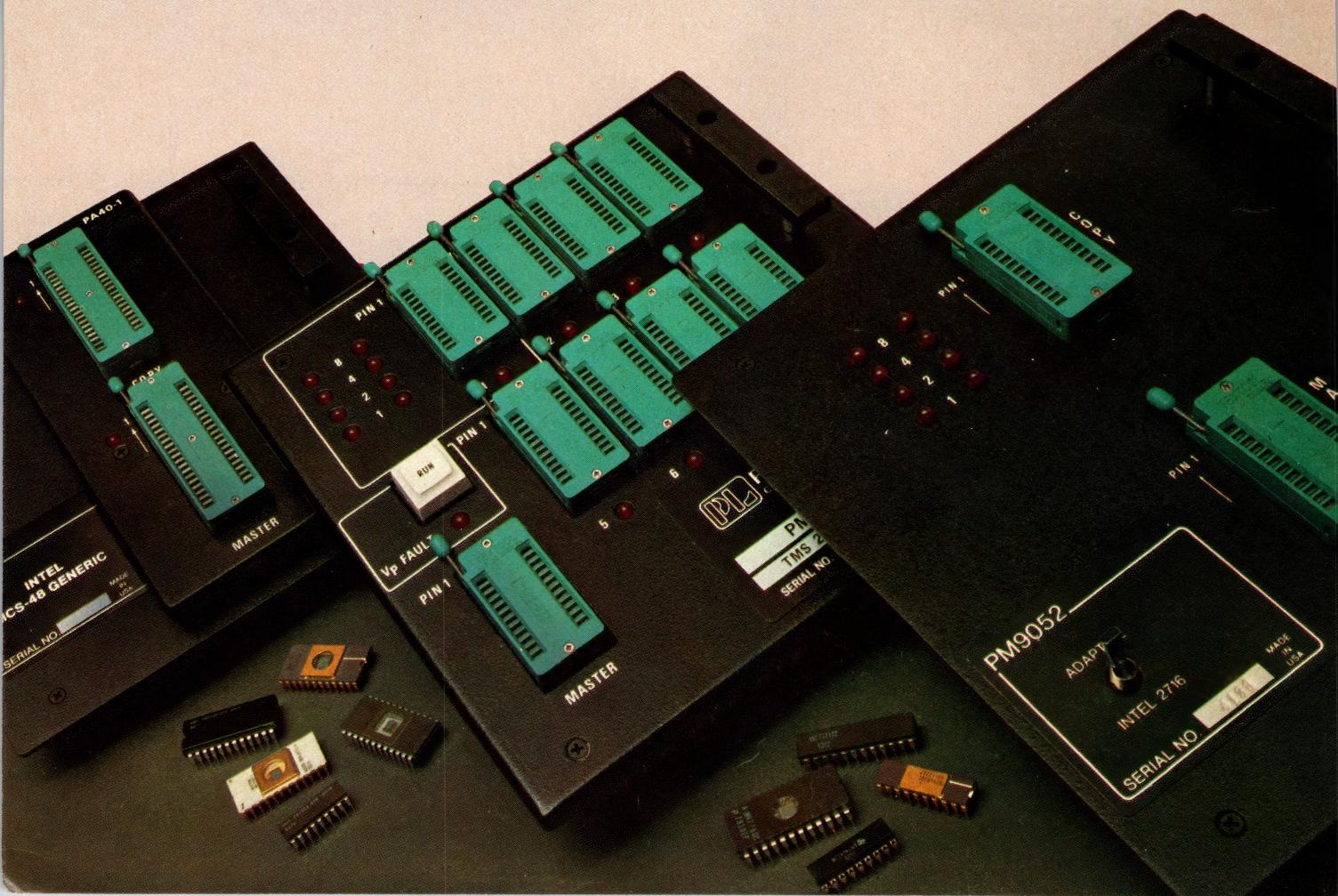
A definitive description of the M980's expanded performance features.

Write or call Pro-Log Corporation, 2411 Garden Road, Monterey, CA 93940, phone (408) 372-4593.



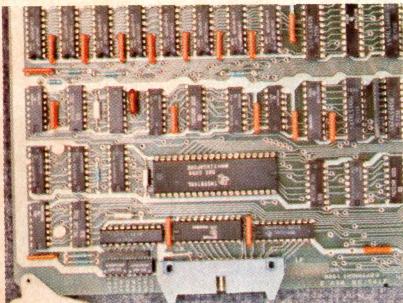
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PRO-LOG PROM PROGRAMMER

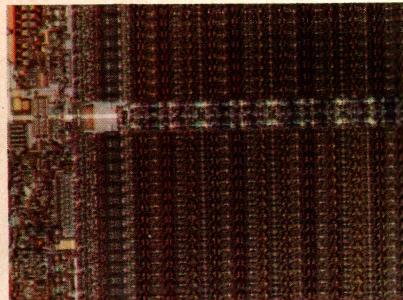


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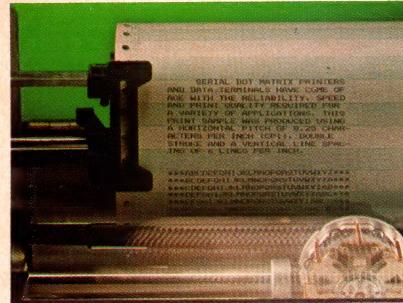
JANUARY 21, 1981 • VOLUME 26, NUMBER 2 • EXCLUSIVELY FOR DESIGNERS AND DESIGN MANAGERS IN ELECTRONICS



Multibus-compatible interface card implements 488-bus controller (pg 71).



EDN's Programmable-Memory Directory reflects expanded options and new device types (pg 106).



On the cover: In the realm of serial impact printers, dot-matrix and fully-formed-character units vie for designers' favor. Turn to pg 90 for more details. (Photo courtesy Texas Instruments Inc)



VBPA



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- Programmable memories make product redesign easy** 106
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- Put theory into practice to motivate your design staff** 120
Novice as well as experienced engineering managers must understand what motivates employees before expecting increased productivity.
- Continuous autocal feature aids resistance measurement** 125
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- Memory-error program evaluates reliability tradeoffs** 131
RAM-error-correction procedures provide benefits—and entail problems—that depend on memory organization and failure rate.
- Article Index, July-December 1980** 139
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- DESIGN IDEAS** 147
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Monolithic op amp specs lowest noise, maintains high speed and precision ... Large-format Z8000-based plotter departs from conventional designs ... Universal fiber-optics analyzer handles lab, field measurements ... Low-cost mechanical keyboard arrays feature rigid monolithic construction.
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Technological leadership.

Cost-effective LSI simplifies central office and

First monolithic SLIC performs BORSHT functions and more . . . MC3419 now available in quantity.

Motorola's bipolar MC3419, the heart of the monolithic SLIC function, is available in quantity. Now production of the world's first transformerless, all-monolithic LSI digital switching line circuits can begin.

The 18-pin MC3419, with support from the Motorola MDA220 transient protection bridge and the specially-designed MJE270 and MJE271 Motorola power Darlington transistors, is all the silicon necessary to perform the BORSHT functions. In fact, the resulting SLIC can do more than the transformer-based circuit.

Availability of the unique new MC3419 SLIC completes the requirements for production of the world's first all-monolithic digital switching line circuits.

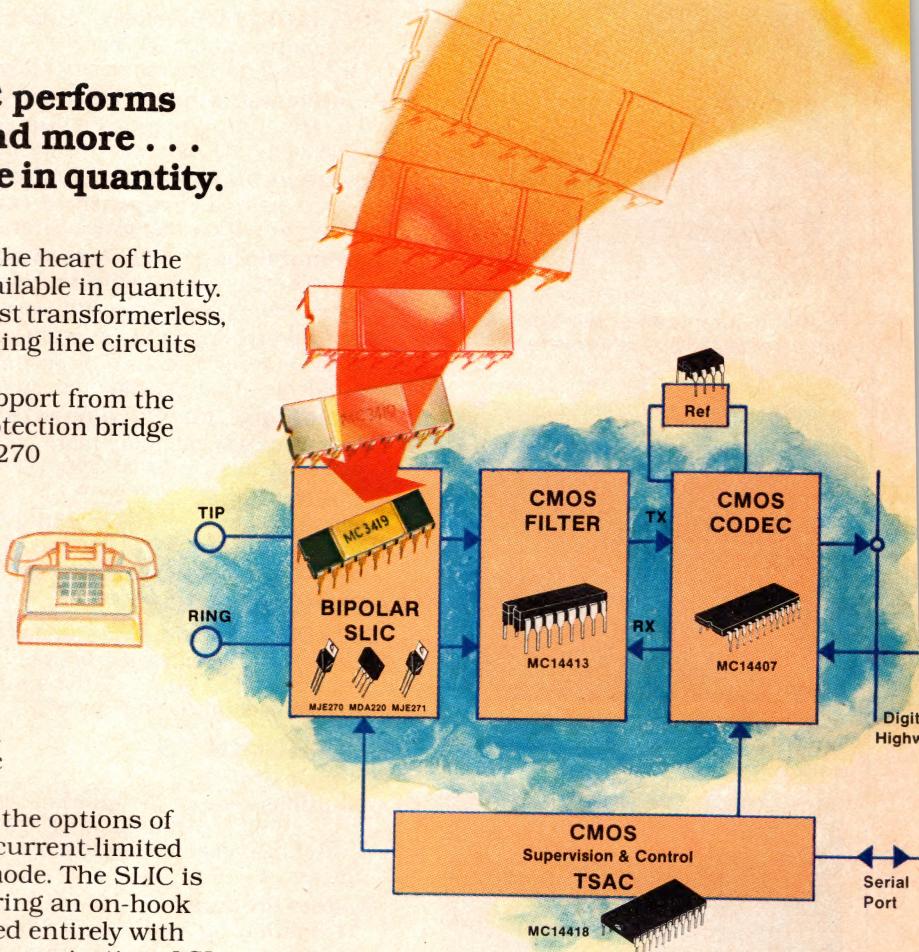
Battery-feed features include the options of feeding the loop resistively, in a current-limited mode or in a constant-current mode. The SLIC is automatically powered down during an on-hook condition. On a line card designed entirely with fully-compatible Motorola telecommunications LSI, one signal will power down the entire card. The power-down features not only save power, they also enhance reliability by minimizing average junction temperature.

Even when powered down, the line is continuously supervised for changes in hook status. That's also useful in line testing. Hook status and Ring trip outputs are provided.

Implementation of the 2-to-4-wire conversion hybrid function is fundamental to the SLIC. In fact, the IC technique used to provide this function is patented. Ground-fault, power line cross and 1500 V lightning protection are all features of the overvoltage and fault protection of the circuit.

The MC3419 is fabricated with Motorola's standard, well-characterized, high-volume linear bipolar process. Additional reliability is achieved by nitride junction sealing.

We recognize the importance to users of a strong second-source. A second-source announcement is anticipated during the first quarter of 1981.

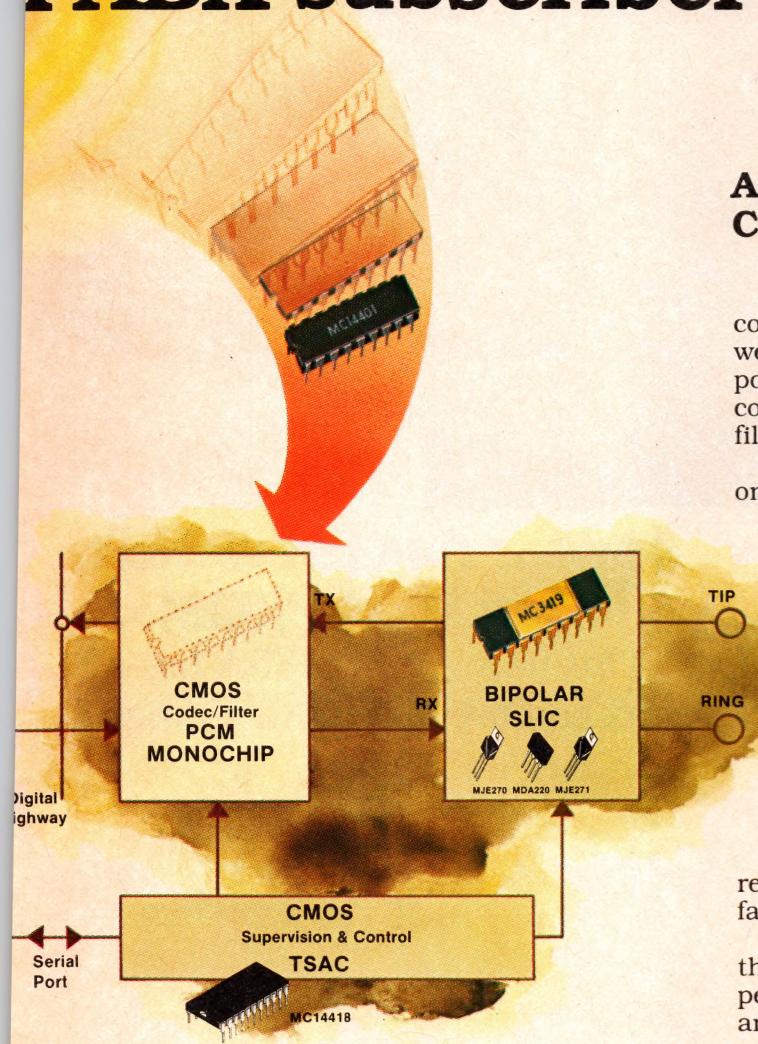


System savings.

When the bipolar MC3419, with its three discrete power devices, is teamed up with Motorola's CMOS families of codecs, filters and TSACs, a cost-effective, low-power and space-efficient, quad line card can be realized. In fact, a bank of eight 7" x 7" quad line cards can be mounted within the area of a 7" cube. Even in such a compact configuration, heat dissipation is absolutely no concern thanks to the lower-power design approach.

In order to minimize component count and save board space, Motorola has taken the system approach to the design of components for the digital line card from the outset. Generic functions were identified, technologies carefully selected, and components designed to interface efficiently with each other as well as with the components of

design, saves space in PABX subscriber channel units.



other suppliers. Features like the single power-down control were designed in from the beginning.

We also recognized that not all functions were generic. The technique for assigning time slots, for example, was seen as heavily dependent on system architecture. Consequently, time slot assigner functions are not integrated into the generic parts, but are offered in a family of stand-alone Time Slot Assigner Circuits (TSACs).

Motorola's commitment to supporting the telecommunications switching market continues into the future. We project, among other things, that the ultimate codec/filter standard will be a 16-pin CMOS PCM Monochip.

Your next opportunity for refining digital switching line circuits will come soon with our MC14400 family of low-power CMOS codec/filter PCM Monochips.

Announcing the upward-compatible CMOS codec/filter PCM Monochip.

Codec, filter and voltage references are all combined in the MC14400 family PCM Monochips we will sample in Q1, 1981. These space- and power-saving CMOS components are completely compatible with existing Motorola codecs and filters, and with other industry-standard devices.

The general-purpose, 16-pin MC14400 provides on-chip voltage reference, pin-selectable TTL and CMOS levels, A-law and Mu-law companding and D3/D4/CCITT/Sign Magnitude formats, synchronous and asynchronous operation, on-chip transmit bandpass and receive low-pass filters.

The others, in 18-pin and 22-pin packages, offer all features of the MC14400 and more. The MC14401 adds selectable full-scale voltages and an input op-amp. The MC14402 also accepts variable data clocks, external voltage reference and external gain adjust. The entire family is MC3419-compatible.

We use producible, tried-and-true CMOS for the PCM monochips for its reliable low-power performance and proven success for complex analog/digital LSI.

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PCM MONOCHIPS

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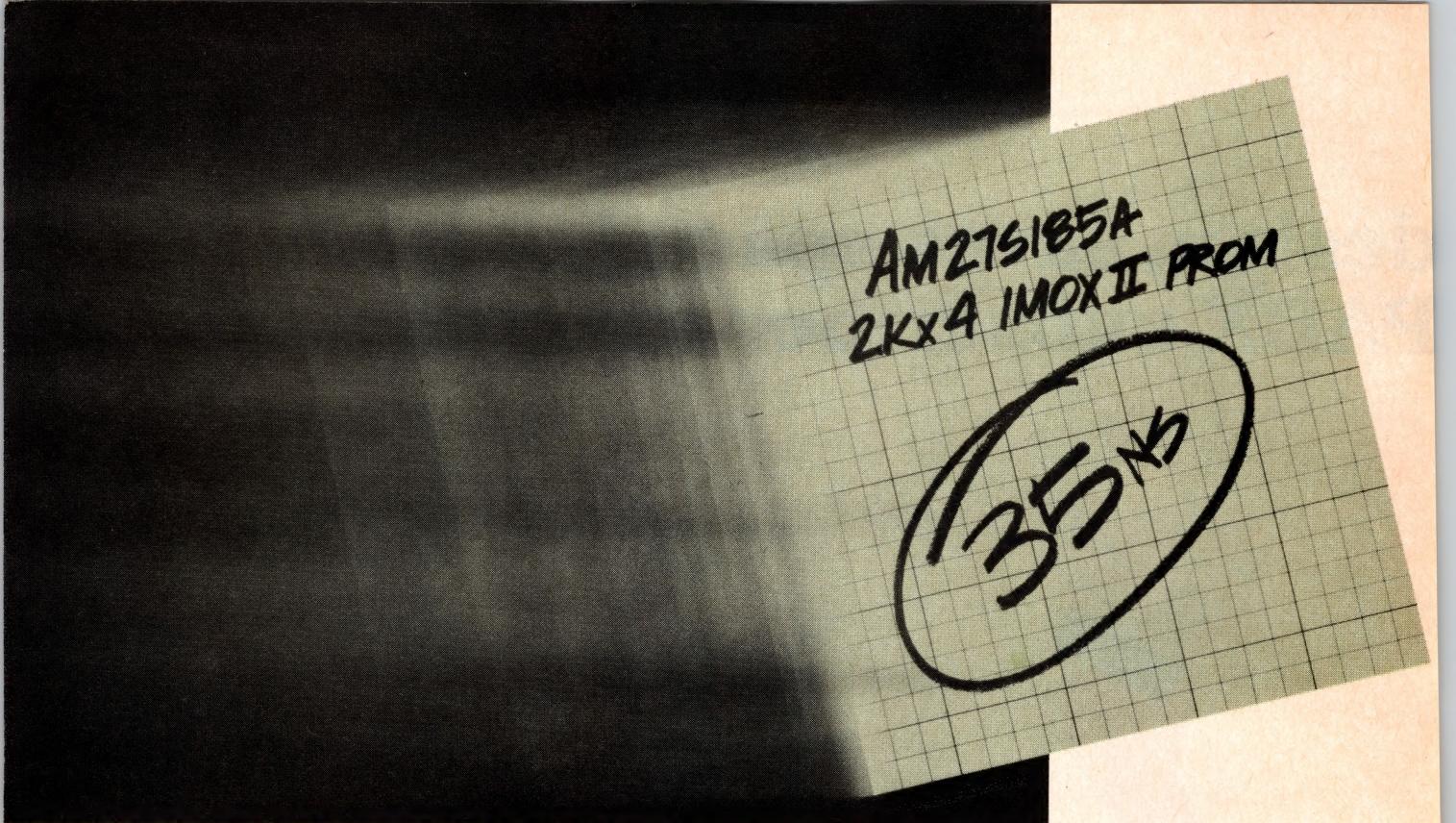
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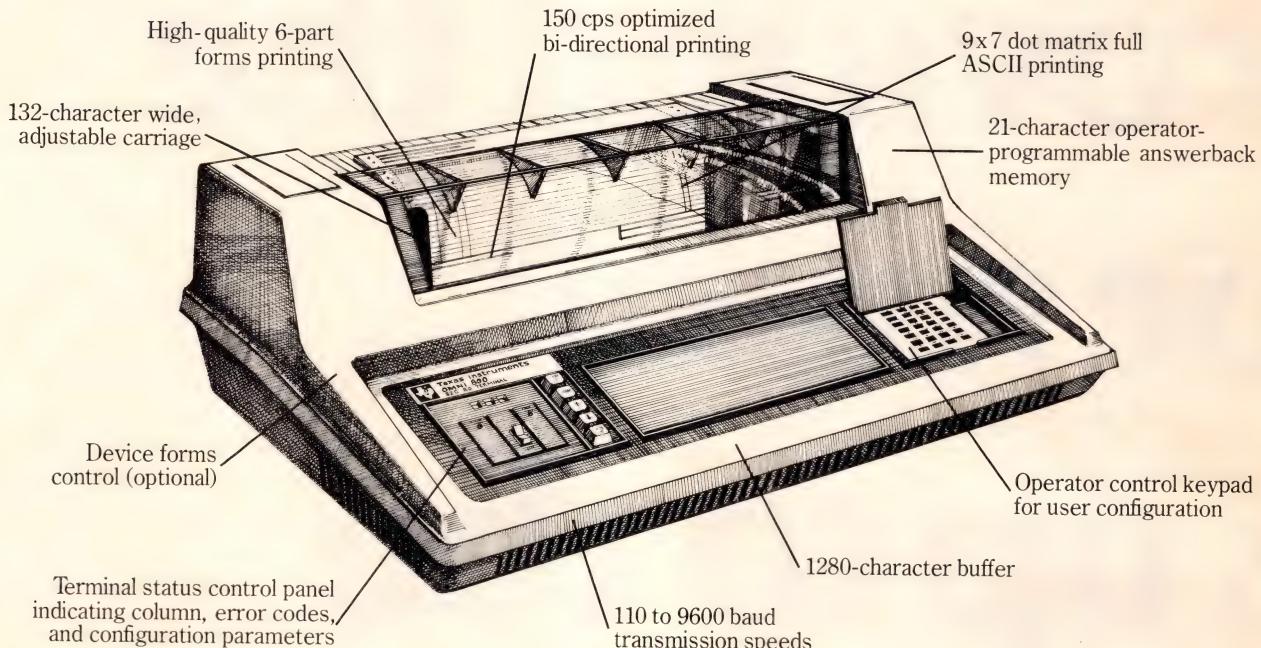


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News Breaks

32-BIT μ P EMPLOYS OBJECT-ORIENTED ARCHITECTURE

Further details on the Intel iAPX 432 μ P were announced at the ACM SIGPLAN Conference on ADA held December 8 to 11. According to Intel representative Steve Zeigler, the 432 is an object-oriented unit that has been under development for 6 yrs. An object-oriented architecture means that high-level entities, such as records, queues, tasks and collections of procedures, are treated as elementary software components; they are thus as easily manipulated as, say, a single-character variable in a Z80.

The 32-bit 432 is implemented on two chips. You can add more processor chips to achieve a multiprocessor system without altering any software.

According to Nicole Allegre, an Intel software engineer working on Project Aloha (Intel's code name for the 432), the firm is currently developing a software environment for the 432, using the DOD's ADA. Allegre indicates that the 432 hardware might be available this quarter, with a basic software environment available in the fall.

Further data on the iAPX 432 is scheduled for presentation at ISSCC '81. See EDN's show preview in the February 4 issue for more details. — WP

UPDATED 488-BUS CONTROLLER ADDS MEMORY, IMPROVED SOFTWARE

Model 3522 from Systron-Donner Corp (Concord, CA) is the huskier brother of the previously introduced \$995 Model 3520 488-bus controller. Housed in the same desktop case as its predecessor, the new instrument features as much as 12k bytes of RAM, compared with the earlier model's 2k memory limit. The 3522's 16k-byte ROM space includes an extended version of the company's control-oriented BASIC language.

This BASIC adds floating-point arithmetic with up to 16-digit precision, Boolean operators, math and trigonometric functions, automatic line numbering and a string package. It includes the earlier version's bus-driver commands, 2-dimensional arrays, subroutines and nested subroutines, single-step operation, error messages and PROM-program/read option.

Model 3522 with 8k bytes of RAM costs \$1995. — AS

LOW-COST MATRIX PRINTER PACKS HIGH-PRICED PERFORMANCE

Model 445 dot-matrix printer sports the lowest price of any Integral Data Systems (Milford, NH) Paper Tiger model. The \$795 unit comes with a ballistic-type printhead, a 36-yd Mobius-loop ribbon cartridge, and motor-driven head, paper and ribbon mechanisms. Key performance features include eight software-selectable character sizes, 80- and 132-column formats, 42 to 300 lpm (depending on line size) at unidirectional speeds to 198 cps, and parallel (Centronics) and serial (RS-232) interfaces. — GK

NEXT-GENERATION SMALL TERMINAL ADDS VERSATILE I/O FEATURES

The TM71-I/O Microterminal from Burr-Brown (Tucson, AZ) follows in the footsteps of its TM25 and TM71 predecessors. But it provides eight more LED status and monitor indicators, noncontinuous or continuous modes for accepting external instruments' input data, decimal or ASCII character output modes and two 8-line ports (one output and one input/output). These extra functions transform the TM71-I/O into a more general-purpose data-gathering and data-distributing station, controlling and monitoring exterior system operations in response to CPU commands. Available this quarter, the TM71-I/O costs \$385 (100); less expensive but dedicated-performance models will make their debut during the year. — GK

News Breaks

GRAPHICS APPLICATION SOFTWARE PACKAGES SERVE NONPROGRAMMERS

Recognizing that most new engineering and scientific graphics-terminals users are nonprogrammers, Tektronix Inc (Beaverton, OR) has introduced seven Plot 50 products, most of them menu driven and including built-in tutorials and "help" files. The graphing, drawing, document-preparation, statistics-generating, planning, project-management and digitizing programs cost \$800 to \$4000. All are upwardly compatible on the firm's 4050, 4052 and 4054 desktop computers and use the new Graphic Model Exchange (GMX) — Tektronix's standard format that allows pictures to pass from one computer to another.

This spring, a trio of products will further expand the Plot 50 applications library; they will cover presentation aids, statistics and 2-dimensional drafting. — WP

TWO-BOARD CONTROLLER SUPPORTS WINCHESTER DRIVES

For S-100-bus systems, the Xcomp (San Diego, CA) 2-board Winchester-drive controller utilizes a microprogrammed data board common to all the firm's controllers. This board operates with a second drive-interface board that supports a variety of drives, including the SA1000 and the ST-506 5½-in. Winchester units. The \$980 SG/S board pair for the SA1000 sports a 256-byte buffer and full-sector buffering. The \$980 Model ST/S for the ST-506 uses the same basic data board as the SG/S but a different interface card. — CW

LOW-COST 16-BIT μ C BOARD RUNS AT 8 MHz

Based on an 8086 μ P that runs at an 8-MHz clock rate, the Multibus-compatible iSBC 86/05 from Intel's OEM μ C Systems Div will debut early next month. The \$1800 board will carry 8k bytes of high-speed static RAM, sockets for four 28-pin EPROMs and three Multimodule sockets for special computing capabilities.

Additionally, the Aloha, OR-based division will emphasize system solutions to OEM design problems in 1981 and will introduce many new software packages to complement its hardware products. The first software offering — to be introduced concurrently with the iSBC 86/05 — is RMX-80, a high-performance real-time operating system with a 16-bit nucleus. — WP

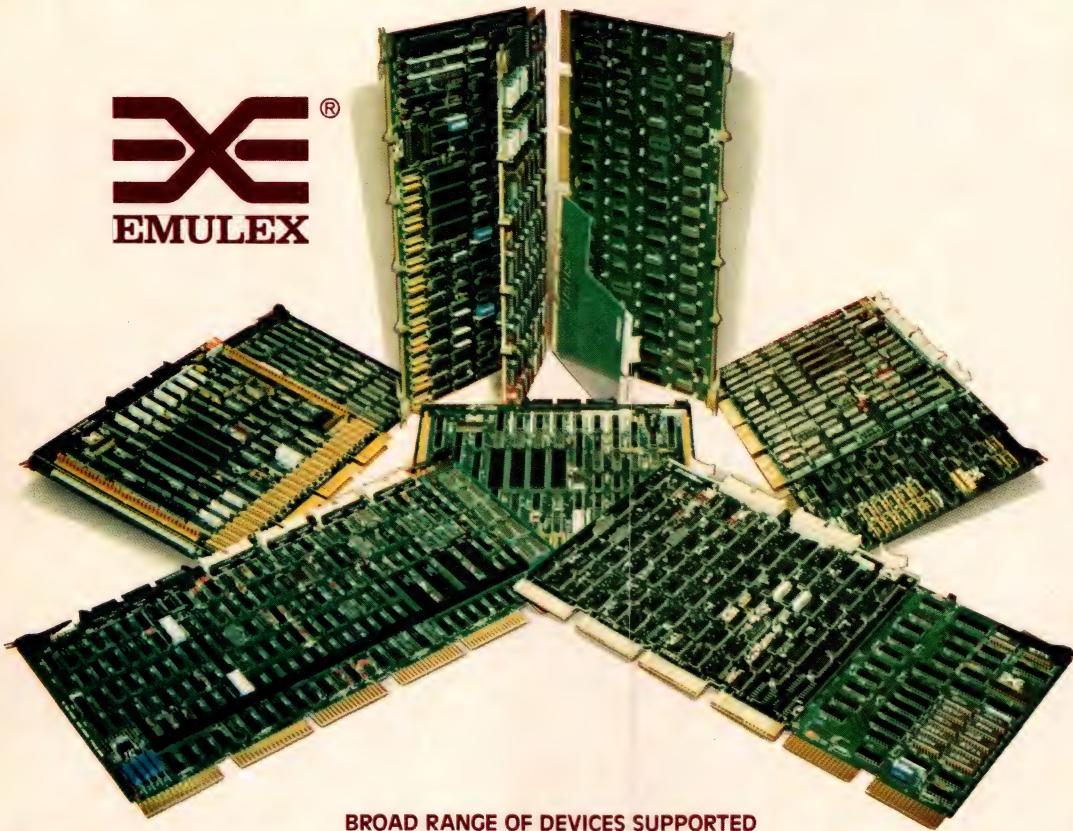
WINCHESTER-DRIVE STORAGE ROCKETS TO 136M BYTES

Available in three models, Ontrax Corp's Series 8 Winchester disk drives feature a patent-pending digital read/write-head-positioning actuator that helps to achieve a 960-tpi storage density on standard 210-mm (8-in.) hard disks. Using dual positioners, five platters and 116 read/write heads, Model 136 from the Sunnyvale, CA-based firm provides a record-breaking 136M-byte unformatted capacity in 9600 data tracks. Models 68 and 34 furnish 68M and 34M bytes, respectively. Evaluation drives will be available in March, with production units expected by the summer. For 200 to 500 quantities, Models 136's cost should start at approximately \$4000. — GK

MAGNETIC SENSING DEVICES MEASURE EXTREMELY-LOW-INTENSITY FIELDS

Experimental superconducting magnetic sensing devices, when incorporated in complete measurement systems, could permit measurement of magnetic field changes as small as 10^{-12} of the earth's field when those changes occur at frequencies greater than 10 kHz. Constructed by researchers at IBM's Thomas J Watson Research Center (Yorktown Heights, NY), these Squids (superconducting quantum interference devices) provide a 100-fold increase in measurement capability over commercial measurement systems that use similar sensing devices. Applications for Squids include searches for geothermal energy sources and minerals, earthquake prediction and heart and brain-wave detection. — AR

PDP-11® and LSI-11® TAPE and DISK CONTROLLERS



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First Computer Corporation, the world's leading DEC computer system integrator now distributes the complete spectrum of EMULEX Tape and Disk controllers for the PDP-11 and LSI-11 family of computers.

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If you survey the field, you'll discover it's been hard to find high density and high speed in an EPROM. Until Intel introduced its new 2764—the one that has both. Plus Intel's complete family of EPROMs—including the 2764—allows you to get control of tomorrow's memory costs today.

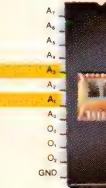
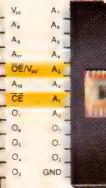
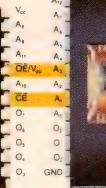
The EPROM standard of tomorrow

Like its predecessor, the 2732A, our new 2764 is fabricated by Intel's proven fourth-generation EPROM technology, HMOS-E. This technology allows us to shrink 2764 die sizes down dramatically, making this the smallest 64K EPROM chip in

production. And HMOS-E makes possible the 2764's standard access time of 250ns. Which means you now have an alternative when you need high speeds and high

densities—in applications such as controller systems for automated milling machines, vector color graphics displays, and over-the-horizon terrain radar.

In addition to high performance, the 2764 brings flexibility and cost control to your system designs. Like all of Intel's EPROMs, the

				
2716 16K 450ns	2732 32K 450ns	2732A 32K 250ns	2764 64K 250ns	2816 16K 250ns E ² PROM



64K EPROM. Now.

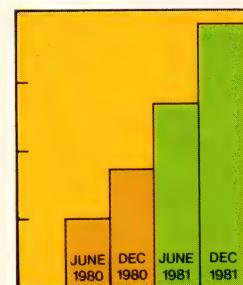
2764's pinout conforms to the 28-pin JEDEC standard for Byte-Wide memories from 16K to 256K bytes. So when you design with 28-pin sites now, you can choose the EPROM that meets your needs today. Then upgrade your memory performance or density later — without any jumpers or expensive engineering changes.

Intel's universal EPROM solution

The 2764 represents the latest addition to our complete EPROM family—the only one that offers you a *universal* EPROM solution that begins with our industry standard 2716 and 2732 EPROMs.

With this solution, your EPROM cost-per-bit will continue to drop.

That means that by mid-1982, high-speed, high-density EPROMs will cost no more per bit than the EPROMs you presently buy. That also means that when it's right for you to upgrade, you'll save valuable board space *and* get increased performance—at no cost penalty.

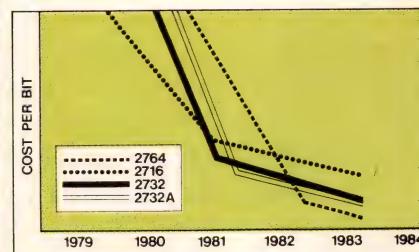


*Intel's EPROM
Production Ramp-up*

already committed to the JEDEC

Byte-Wide memory pinout standard,
further increasing your design
choices.

Our Byte-Wide memory family also includes the revolutionary 2816 E²PROM. It shares the identical pinout and 2K-byte data capacity as our 2716 EPROM. But the 2816's E² technology is the starting point for the next revolutionary step in non-volatile memories: in-system reprogrammability. Imagine the possibilities. Reconfigurable aircraft systems. Automatically adjusting machine tool controllers. Self-calibrating measurement equipment. Until the 2816, these designs have been impossible.



Cost-Per-Bit Decline for Intel EPROMs

Measuring the EPROM field

Only Intel offers you an EPROM solution with the widest range of speeds, densities, and performance. We back up this choice with the proven reliability that comes from HMOS technology and ten years of EPROM manufacturing experience. Plus we offer field support and technical documentation that leads the industry all the way.

For further information about Intel's EPROM family, including the new 2764 and 2816 E²PROM, contact your local Intel distributor or sales office. Ask for the "Intel EPROM Applications Manual." Or write directly to Intel Corporation, Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051. Telephone (408) 987-8080.

*HMOV is a patented Intel process.

Europe: Intel International, Brussels, Belgium.
 Japan: Intel Japan, Tokyo. United States and Canadian
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News Breaks

SPEAKING OF VOICE I/O . . .

If you're curious about Telesensory Systems Inc's Series III speech units (EDN, Editor's Choice, January 7), you can now hear what they sound like by calling (415) 856-0225. You'll hear samples of systems' LPC speech and some direct conversion from text to speech. — ET

PRODUCT HIGHLIGHTS FROM INTELCOM '80 . . .

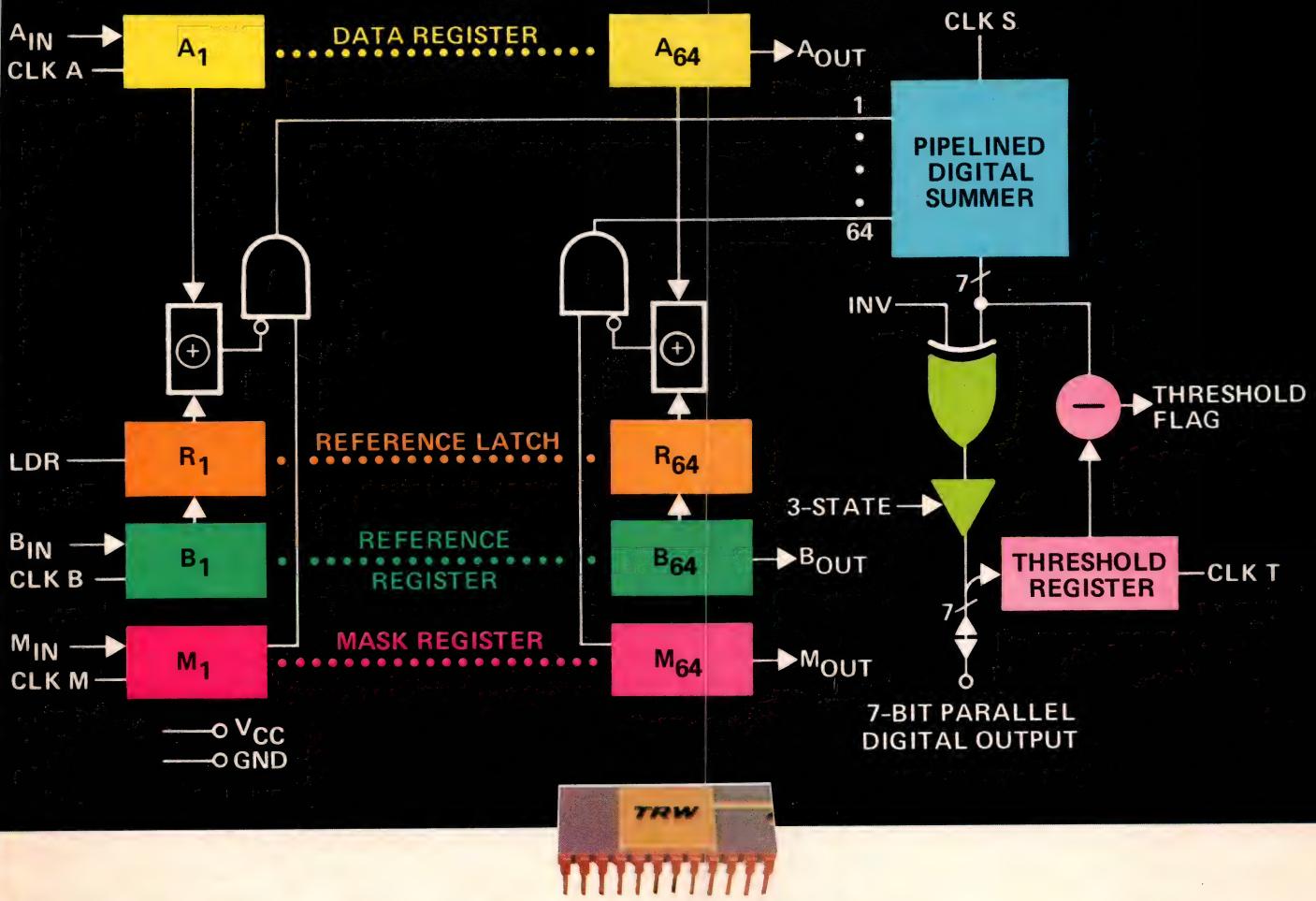
The International Telecommunication and Computer Exposition held in Los Angeles in November provided the site for some significant product introductions. For example, Novation (Tarzana, CA) introduced the FCC-approved Auto-Cat auto-answer direct-connect modem. Compatible with Bell's 100 Series modems, the \$249 device exchanges data at 0 to 300 baud for full- or half-duplex modes. Weighing only 12 oz, the line-powered 10×4.7×1.2-in. device easily fits under a telephone.

Also at the show, American Microsystems (Santa Clara, CA) displayed its Model S3505 as the first CMOS single-chip-per-channel codec with built-in encoder, decoder and input and output filters. Furnishing an internally derived reference voltage for A/D and D/A conversions, it reduces subscriber-line-interface complexities and costs for digital PABXs and control-office signaling equipment. Meeting or exceeding AT&T D3 and CCITT G.711 and G.733 specifications, the codec handles serial data rates from 64k to 2.1M bps at an 8-kHz nominal sampling rate. To suppress crosstalk, a switched-capacitor circuit furnishes 80-dB separation between transmitter/filter and receiver/filter sections. Housed in 24- or 28-pin ceramic or CerDip packages, the S3505 costs \$40, with prototype and production quantities available in the first and third quarters, respectively.

Finally, the FT3 and FT3C telecomm fiber-optic cables were introduced by Seicor (Hickory, NC). They come in 6-, 8-, 10- and 12-fiber versions. At 850 nm, the FT3 cable specs a 5-dB/km attenuation and 250-MHz-km bandwidth; the FT3C cable rates at 4.5 dB/km and 500 MHz-km. Both types are available for aerial, duct and buried installations. From stock, FT3 cable costs from \$4.50 to \$9.65 per metre; the FT3C type, from \$5.40 to \$11.45 per metre. — GK

FOR YOUR CALENDAR . . .

The NASA/Marshall Space Flight Center, in cooperation with the Components, Hybrids and Manufacturing Technology Society of IEEE, will hold a seminar to highlight capacitor technologies, applications and reliability. Nineteen papers will cover ceramic, metallized polycarbonate, PVF₂ and electrolytic capacitors. You can contact Leon Hamiter at NASA/EC43, Marshall Space Flight Center, AL 35812, or phone (205) 453-4562 for more details on the February 24 to 25 seminar... "The 1981 Communications Techniques Seminar: Digital Communications" will be held at Princeton University on March 24. Presentation topics will include two digital data networks (one military and one commercial), packetized subscription TV, the proposed Northeast lightwave corridor and a comparison of digital and packet communications. Get in touch with Cynthia A. Donovan, Secretary, Room 2F512A, BTL, Holmdel, NJ 07733 for more information. — JM



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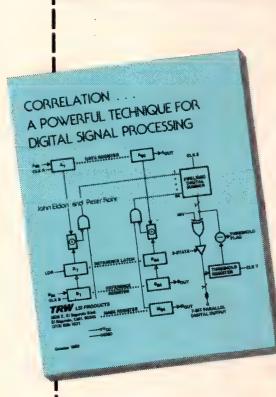
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Signals & Noise

Complaints about convention conditions

(*Ed Note: A reader sent EDN a copy of the following letter—the original was addressed to the Wescon/80 organizers.*)

Gentlemen:

Like many other engineers, I attended your recent convention at the Anaheim Convention Center. The conference was fine, the displays were excellent and the presentations were acceptable. The big loser, however, was the Anaheim Convention Center itself. The streets of Anaheim are clearly incapable of handling convention traffic, even during the working day. The effects of a convention plus normal street traffic almost totally halted movement. That's bad, but then that's typical of Anaheim, which hasn't totally adjusted to the presence of Disneyland—after all, it's only been 25 yrs.

The Convention Center owns the signs surrounding it, which say "parking" and indicate how to get to it. But there is no parking lot at the end of these signs (which stop abruptly), only a loading area. One parking lot that we drove by had empty slots in it, yet a person who hardly spoke English said she couldn't let us in because her boss said not to. The car ahead of us got in, though, for unclear reasons.

We were told to park at Disneyland, which we did. The only reason we were finally able to park anywhere near the Convention Center was because we ignored a sign that directed us another way. The exit from the Disneyland parking area was somewhat near the Center (near doors marked "other door, please") and a long way from the traffic signals. Apparently,



Disneyland was trying to discourage convention attendees from using its lot.

Inside the Center, we found the aisles often blocked by many people. Use of the food services was out of the question because of the length of the lines—not just at noon, but throughout the entire day. As near as I could tell, the popularity of those places was not based on low prices, but simply on hunger and thirst.

If you got a much bigger crowd than you expected, these types of conditions are understandable. But don't let it happen again. If you decided, however, just to let it become crowded and have everyone fend for himself, you should be ashamed. I wrote the Anaheim Convention Center's manager about these conditions and have received no reply after 2 weeks, so I imagine that the Center's management is partly to blame.

Your early registration is a boon; it saves waiting in lines for a badge as required at past Wescons. To further help attendees, you might also

"We've always been a jump ahead of device technology. And that's where we intend to stay."

Jim Fischer
GENERAL MANAGER
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"Ten years ago, we started the Tektronix S-3200 Series of Semiconductor Test Systems. Time has shown that we've built an excellent foundation. This same basic concept accommodates any chip made today and many that are still on the drawing board. We're continually refining the concept and making it a logical solution to contemporary measurement problems. The new Tektronix S-3275 Semiconductor Test System is the latest example of our permanent commitment to anticipate upcoming measurement problems and meet them head on.

"The 1980's are already bringing very sophisticated measurement challenges. Things like the proliferation of VLSI and analog/digital devices present test complexities that defy direct human solution. Our S-3200 Series has now evolved to the point where it can easily cope with these types of measurements, even in the subnanosecond range. We've put the proper tools right at the engineer's fingertips.

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The S-3200 Series of Semiconductor Test Systems is just one more example of Tektronix' commitment to excellence. For 34 years, we've been continually making the engineer's job easier through an unbeatable combination of technical innovation and superior quality. As technology advances toward more refined horizons, Tek will continue to be there with a solution to match.

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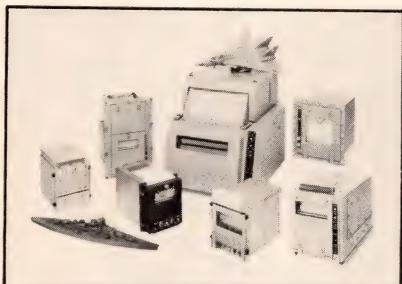
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If you have an idea for an EDN design feature, send us an outline or call the Editor to discuss your proposal. We pay \$30 per magazine page, upon publication, for every contributed feature article. Call Walt Patstone, 221 Columbus Avenue, Boston, MA 02116. Telephone (617) 536-7780.

Signals & Noise

include parking and shuttle-bus information with registration materials. You should be able to hold a large convention and provide adequate parking, shuttle buses, room in the aisles and refreshments after a wait of a couple of minutes or less. I've seen it done at the NAB in Las Vegas. If you can't get the service you need from the place you use, use another. The Los Angeles site wasn't bad; you could also consider Las Vegas.

I doubt that I'm the only person with these feelings. Maybe you might consider using a statement like "we've got our act together" in your promotions for the next Wescon.

Sincerely,
James Rieger
Engineer/PTBW
Ridgecrest, CA

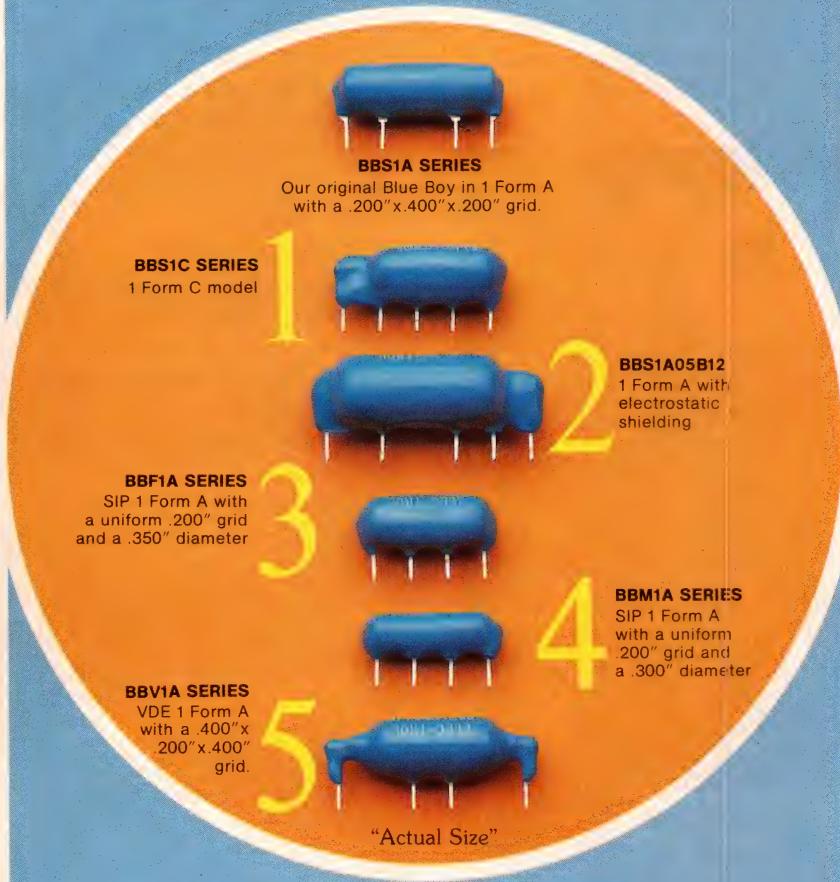
You'll need the proper address

The address given for Waterloo Distance Education Inc on pg 22 of EDN's September 5, 1980, News Breaks was incorrect. The correct one is Box 62, Waterloo, Ontario, Canada N2J 3Z6.

Your turn...

EDN welcomes your comments, pro or con, on any issues raised in the magazine's articles. Address letters to Signals and Noise Editor, EDN, 221 Columbus Ave, Boston, MA 02116. Names will be withheld upon request. We reserve the right to edit letters for space and clarity.

ELEC-TROL BLUE BOY REED RELAYS



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All units in the Blue Boy line incorporate hermetically sealed reed switch contacts encapsulated in rock-hard blue epoxy for low-cost protection against hazardous environments, production cleaning solvents, and rough handling.

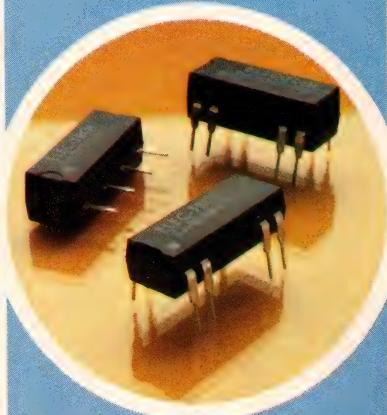
Send for more information, or for prices and samples, contact your local Elec-Trol distributor or representative.

Elec-Trol, Inc., 26477 N. Golden Valley Road, Saugus, CA 91350, (213) 788-7292 (805) 252-8330. TWX 910-336-1556.

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Books

Analog basics, revised and updated

IC Op-amp Cookbook (second edition), by Walter G Jung. 480 pgs; \$14.95 (paperback); Howard W Sams & Co, Indianapolis, IN, 1980.

Analog-circuit engineers have never had it so good—literally.

Technology has recently yielded a generation of IC op amps that sport outstanding dc and dynamic specifications; indeed, for many applications, the newest devices very closely approximate ideal components.

If there's a bad-news side to this good-news story, it reflects

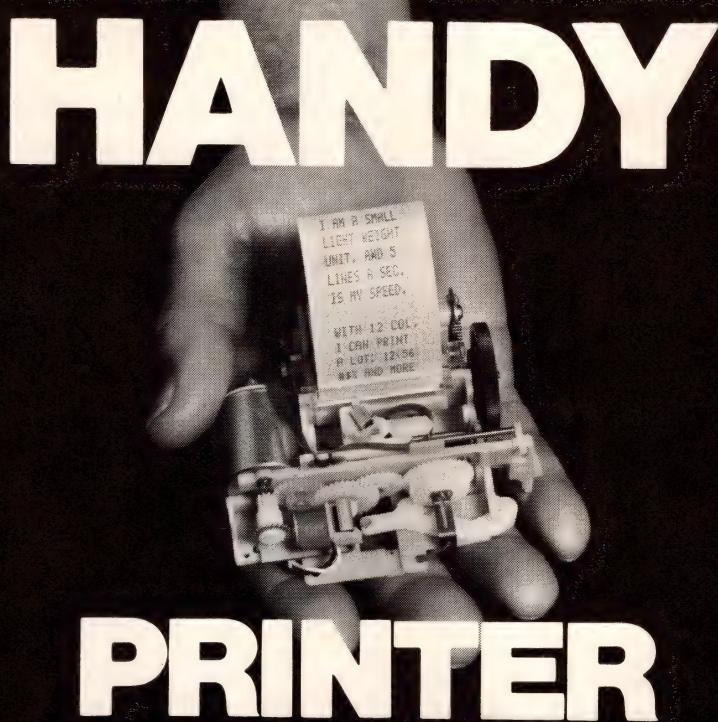
the growing obsolescence of your analog-design reference library. Although basic theories haven't changed, many classic texts contain circuit examples that have become obsolete by today's standards. Realizing this obsolescence, Walter Jung rewrote and reorganized almost half of his popular 1974 tutorial to reflect contemporary analog design techniques. In addition, he has researched the latest commercially available single, dual and quad FET and bipolar op amps; summarized and tabulated their capabilities; and illustrated their use in challenging applications.

Separate chapters cover voltage regulators and references, signal-processing circuits, log amps and multipliers, amplifiers, comparators, integrators and differentiators, and signal generators. In each, schematic diagrams denote component values and specific op-amp types.

To help you transform theory into practice, Chapter 2 details specialized groups of devices and provides numerous selection charts; an appendix supplements this text with part-number breakdowns and data sheets.

Given all of Mr Jung's expansions to the first edition, it's small wonder that this second edition required some deletions to remain less than 500 pgs long. Thus, the original book's sections on "Audio" and "Unique Devices" are now available (in expanded form, of course) as separate, stand-alone texts. Nevertheless, a broad range of subjects remains.

As a guide to the shades-of-grey analog world, we find this book's countless design examples interesting, useful and documented in commendable detail. —Walt Patstone



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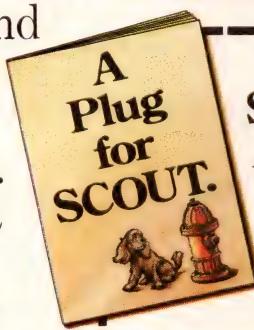
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EDN 1/21/81

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All devices in TI's TMS2500 EPROM Family are plug-

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Plug-in compatibility means easy upgradability. From 8K to 64K. For upgrading from 16Ks to 32Ks, for example, just include the signal to PD in the address decoder. No jumpering. Minimal modification for upgrade to 64K. And beyond.

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Family portrait.

Check the chart and choose the member of TI's growing EPROM Family for your application. From the world's fastest 8K to a high-performance 16K to a fast new version of the industry's first standard 32K to the industry's first 64K.

Availability.

Right now delivery on all devices from your local TI field sales office or authorized distributor.

For more information about the industry's first EPROM Family, and other Texas Instruments EPROM products, write to Texas Instruments Incorporated, P.O. Box 1443, M/S 6965, Houston, Texas 77001.



TI's Growing TMS2500 EPROM Family

Device	Description	Power Dissipation*	Access Time*
TMS2564-45	64K	840 mW	450 ns
TMS2532-45	32K	840 mW	450 ns
TMS2532-35	32K	840 mW	350 ns
TMS25L32-45	32K	500 mW	450 ns
TMS2516-45	16K	525 mW	450 ns
TMS2516-35	16K	525 mW	350 ns
TMS2508-30	8K	446 mW	300 ns
TMS2508-25	8K	446 mW	250 ns

*Worst case over operating temperature range

TEXAS INSTRUMENTS

INCORPORATED
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The Remarkable Intelligent Display



It's the ideal readout for interactive systems

REMARKABLE

Want a sure way to label your "smart" system as a product of the 80's?

Give it the ability to communicate, not in lights, but in operator language.

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The Intelligent Display is a 4-character, 17-segment alphanumeric module that interfaces just like a RAM and can be stacked to any length. It has a CMOS chip that includes an ASCII decoder, multiplexer, memory and LED driver. Litronix also offers a pre-engineered Intelligent Display Assembly™ with either 16 or 32 characters.

A new generation of systems that communicate interactively

Intelligent Displays are now being designed into a broad range of "smart" industrial and consumer products.

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And don't forget personal computers.

If you are designing or updating products to take advantage of today's microprocessor technology, doesn't it make sense to take it one step further...and give your products the ability to communicate?

With a Litronix Intelligent Display it couldn't be easier.

For information contact Litronix, 19000 Homestead Road Cupertino, CA 95014. (408) 257-7910.

Part Number	Character Height	Horizontal Row Spacing	Vertical Row Spacing	Viewing Angle	Character Positions	Character Segments
DL-1414	.112"	.175"	.800"	±40°	4	17
DL-1416	.160"	.250"	1.200"	±25°	4	16
DL-2416	.160"	.250"	.800"	±50°	4	17

IDA-2416-16, Intelligent Display Assembly, 16 characters

IDA-2416-32, Intelligent Display Assembly, 32 characters

U.S. Distributors: Advent, Almac-Stroum, Arrow, Component Specialties, Gerber, Hamilton Avnet, Harvey, Kirkman, Lionex, Marshall, Moltronics, Pioneer-Standard, Summit and Zeus. Canadian Distributors: C.M. Peterson, Electro Sonic, Future, Hamilton Avnet and L.A. Varah.

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Editorial



A step backwards for quality?

Quality has become the most popular buzzword in the electronics industry today, particularly in the semiconductor segment. Spurred by the achievements of some Japanese manufacturers, many US firms have given top priority to improving their own products' quality.

Such an emphasis is a positive result of the Japanese competition. However, EDN fears that a giant step backwards might occur in 1981 because of the current mad scramble to capture 64k-RAM market share.

In that scramble, semiconductor manufacturers (US and Japanese alike) appear to be abandoning traditional learning-curve pricing methods, as indicated by the latest rounds of "price bombing." Some firms that have barely run first silicon are participating in this price war, yet they can't really be sure they can manufacture production quantities that meet announced specs. And all the competitors, even those few currently

delivering production parts, are being denied the chance to recover huge front-end R&D costs.

So what's likely to happen in 1981? Some companies, faced with large quantities of marginal-performance, early-production parts, will dump them on the market at very low prices merely to cut their losses. And that action will not only erode the prices of parts that meet specs, but also establish a quality level well below what companies are now striving for.

The leading computer manufacturers will certainly maintain their procurement standards; they won't specify these low-cost, marginal-performance memory chips. But some other companies could lower their sights just to get scarce parts, or to take advantage of the lower prices. And if that happens, the computer market will be flooded with a substantial quantity of low-quality, unreliable equipment.

EDN urges you to avoid 64k RAMs exhibiting marginal performance levels. Many of you will also have to beef up your incoming-inspection operations to insure that marginal parts aren't slipped in with the good ones. (It's happened before.)

The alternative? Double or even triple your field-service force. And if you choose that alternative, be prepared to live down a poor reputation for quality for a long, long time—should you survive the competition at all.

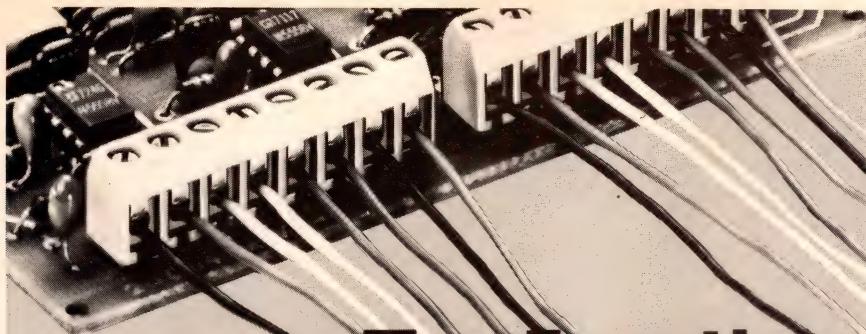
A handwritten signature in cursive script that reads "Roy W. Forsberg".

Roy Forsberg
Editorial Director

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System Design Project
- 1978 Contributed Series—
Designer's Guide to Fiber Optics
- 1977 Contributed Series—
Software Design Course
- 1976 Special Issue—
Microprocessor Reference Issue
- 1975 Staff-Written Series—
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*Jesse H Neal Editorial Achievement
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Prize equivalent.



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Multibus™ Intel Corp.

Leadtime Index

ACTIVE COMPONENTS

PRODUCT	LEADTIME IN WEEKS			PRODUCT	LEADTIME IN WEEKS		
	Min.	Max.	Trend		Min.	Max.	Trend
DISCRETE SEMICONDUCTORS				MEMORY CIRCUITS			
Diode, switching	6	10	=	EPROM	4	12	=
Diode, zener	5	10	=	PROM, bipolar	14	30	=
Rectifier, low-power	5	12	=	RAM, bipolar	15	27	=
Rectifier, power	5	12	=	RAM, CMOS	7	12	=
Thyristor, low-power	7	12	=	RAM, 4k MOS dynamic	8	15	up
Thyristor, power	7	13	=	RAM, 16k MOS dynamic	9	14	=
Transistor, bipolar power	6	12	=	RAM, 1k MOS static	7	10	=
Transistor, bipolar signal	8	14	=	RAM, 4k MOS static	10	14	=
FET, power	5	14	=	ROM, masked MOS	16	18	up
FET, signal	7	14	=				
Transistor, RF power	7	12	=				
DISPLAYS				MICROCOMPUTER/MEMORY SYSTEMS			
Fluorescent	6	11	=	Core memory board	9	13	=
Gas-discharge	5	12	=	IC memory board	7	12	=
Incandescent	6	10	=	Interface board	8	11	=
LED	5	11	=	Microcomputer board	6	12	=
Liquid crystal	4	18	=				
Plasma panel	6	16	=				
ELECTRON TUBES				MICROPROCESSOR IC'S			
CRT, black and white TV	4	13	=	CPU, bipolar bit slice	7	15	=
CRT, color TV	8	12	=	CPU, 4-bit MOS	12	18	=
CRT, industrial	6	14	=	CPU, 8-bit MOS	6	14	=
Industrial power	8	16	=	CPU, 16-bit MOS	7	16	=
Light and image sensing	6	12	=	Peripheral chip	7	10	=
Microwave power	14	18	=				
INTEGRATED CIRCUITS, DIGITAL				OPTOELECTRONIC DEVICES			
CMOS	10	25	=	Coupler and isolator	8	13	=
Diode transistor logic (DTL)	10	16	=	Discrete light-emitting diode	6	12	=
Emitter-coupled logic (ECL)	10	20	=				
Low power Schottky TTL	14	26	=				
Standard Schottky TTL	15	24	=				
Standard TTL	12	17	=				
INTEGRATED CIRCUITS, LINEAR				PACKAGED FUNCTIONS			
Communications circuit	8	13	=	Amplifier, instrumentation	6	15	=
Data converter	8	14	=	Amplifier, operational	6	18	=
Interface circuit	7	12	=	Amplifier, sample/hold	7	14	=
Operational amplifier	8	15	=	Converter, analog/digital	7	15	=
Voltage regulator	5	11	=	Converter, digital/analog	7	15	=
				PANEL METERS			
				Analog	7	14	=
				Digital	6	14	=
				POWER SUPPLIES			
				Custom	13	19	=
				Enclosed modular	12	15	=
				Open-frame module	10	16	=
				Printed circuit	10	14	=

Leadtimes are based on recent figures supplied to *Electronic Business* magazine by a composite group of major manufacturers and OEMs. They represent the typical times necessary to allocate manufacturing capacity to build and ship a medium-sized order for a moderately popular item. Trends represent changes expected for next month.

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SINGLE OUTPUT MODELS					
AC INPUT(1)	PM2496A	PM2497A	PM2498B	PM2499	PM2500
DC INPUT(2)	PM2721	PM2722			
TOTAL OUTPUT	250- 300W	500- 750W	1000- 1500W	1000- 1100W	1000W
OUTPUT VOLTAGE	OUTPUT CURRENT				
2	100	200	400	300	
3	60	100	200	200	
5	50	120	200	200	200
6	60	150	300		
12	25	60	120	85	
15	25	50	100	70	
24	16	33	66	45	
28	13	27	54	40	
48	8	16	32	24	
CASE SIZE:	5"x8"x11"				

MULTIPLE OUTPUT MODELS					
AC INPUT(3)	PM2675A	PM2676A	PM2677A	PM2678A	PM2679
DC INPUT(4)	PM2775(4)	PM2776(5)	PM2777(6)	PM2778(7)	
MAX. TOTAL OUTPUT	375W	600W	750W	850W	1000W
MAIN CHANNEL	OUTPUT VOLTS	2, 3, 5, 12, 15, 18, 21, 24, 28, 48VDC			
	MAX. POWER	250W	500W	600W	750W
2nd & 3rd CHANNEL	OUTPUT VOLTS	5, 12, 15, 18, 21, 24, 28VDC			
	OUTPUT CURRENT	10	10	10	Check Factory
4th CHANNEL	OUTPUT VOLTS	5, 12, 15, 18, 21, 24, 28VDC			
	OUTPUT CURRENT	4	4	4	4
CASE SIZE:	5"x8"x11"				

- SINGLE OUTPUT
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MULTIPLE OUTPUT
3) 92 to 138 or 184 to 250 VRMS single input.
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5) 48, 120, 240 VDC
6) 120, 240 VDC
7) 120, 240 VDC.

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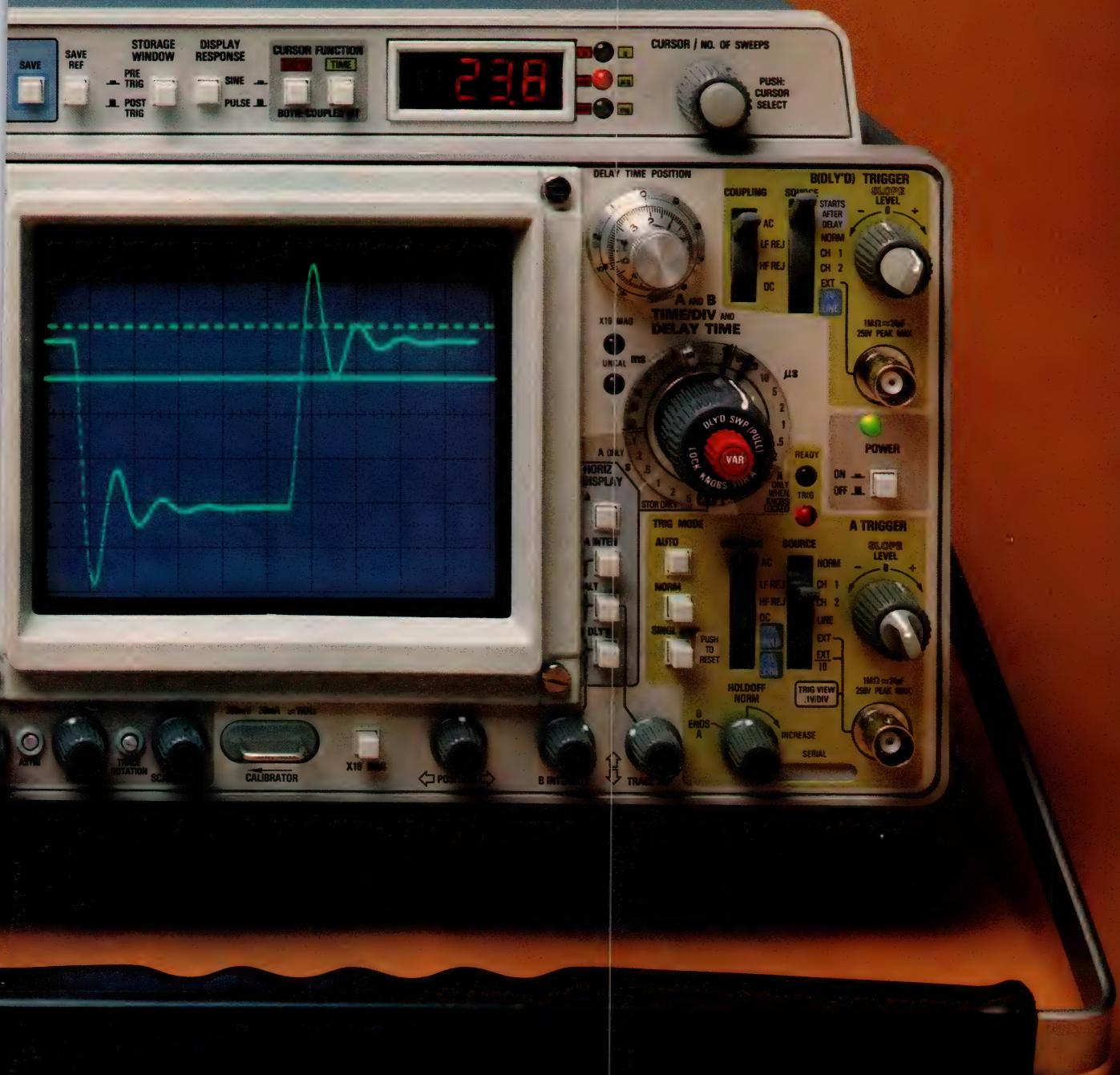
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Selecting the right microcomputer for your product is tricky business. There are so many variables. Like the technology. What's available to fit your design requirements? With how many on-chip functions? How many instructions? How fast? How much memory?

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Three technologies

Panasonic MN1400's are available as C-MOS, P-MOS and N-MOS to fit your specific design requirements. You can fit the right chip to your design.

Model	Package	On Chip Memory	
		Instruction ROM	Data RAM
N-MOS	MN1400	40 Pin DIP/Plastic	1024 x 8 bits
	MN1402	28 Pin DIP/Plastic	768 x 8 bits
	MN1403	18 Pin DIP/Plastic	512 x 8 bits
	MN1404	16 Pin DIP/Plastic	512 x 8 bits
	MN1405	40 Pin DIP/Plastic	2048 x 8 bits
	MN1498	40 Pin DIP/Plastic	External
P-MOS	MN1430	40 Pin DIP/Plastic	1024 x 8 bits
	MN1432	28 Pin DIP/Plastic	768 x 8 bits
	MN1435	40 Pin DIP/Plastic	2048 x 8 bits
C-MOS	MN1450	40 Pin DIP/Plastic	1024 x 8 bits
	MN1453	18 Pin DIP/Plastic	512 x 8 bits
	MN1454	16 Pin DIP/Plastic	512 x 8 bits
	MN1455	40 Pin DIP/Plastic	2048 x 8 bits

Varying computing power

The 12-strong MN1400 microcomputer family offers devices with varying amounts of computing power, so you can choose the chip that meets your specific requirements. And even if your memory needs change, you can substitute another model within the family and save your basic design. You pay only for the computing power you need.

They're all on the chip

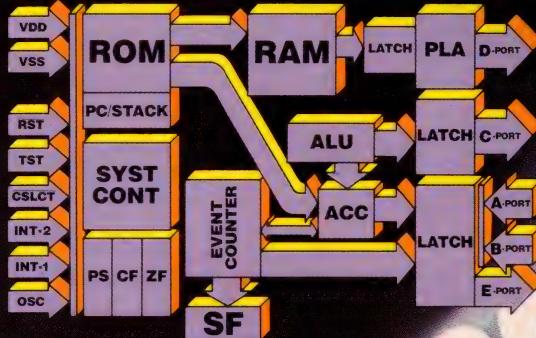
We put all these microcomputer functions on a single chip:

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- 4-bit parallel output port

Add to that the fast 10 μ s instruction speed and a powerful instruction set with up to 75 versatile instructions that let you computerize a variety of end products with ease.

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Technology News

EEPROMs gain in density and speed, threaten to displace UV EPROMs

William Twaddell, Western Editor

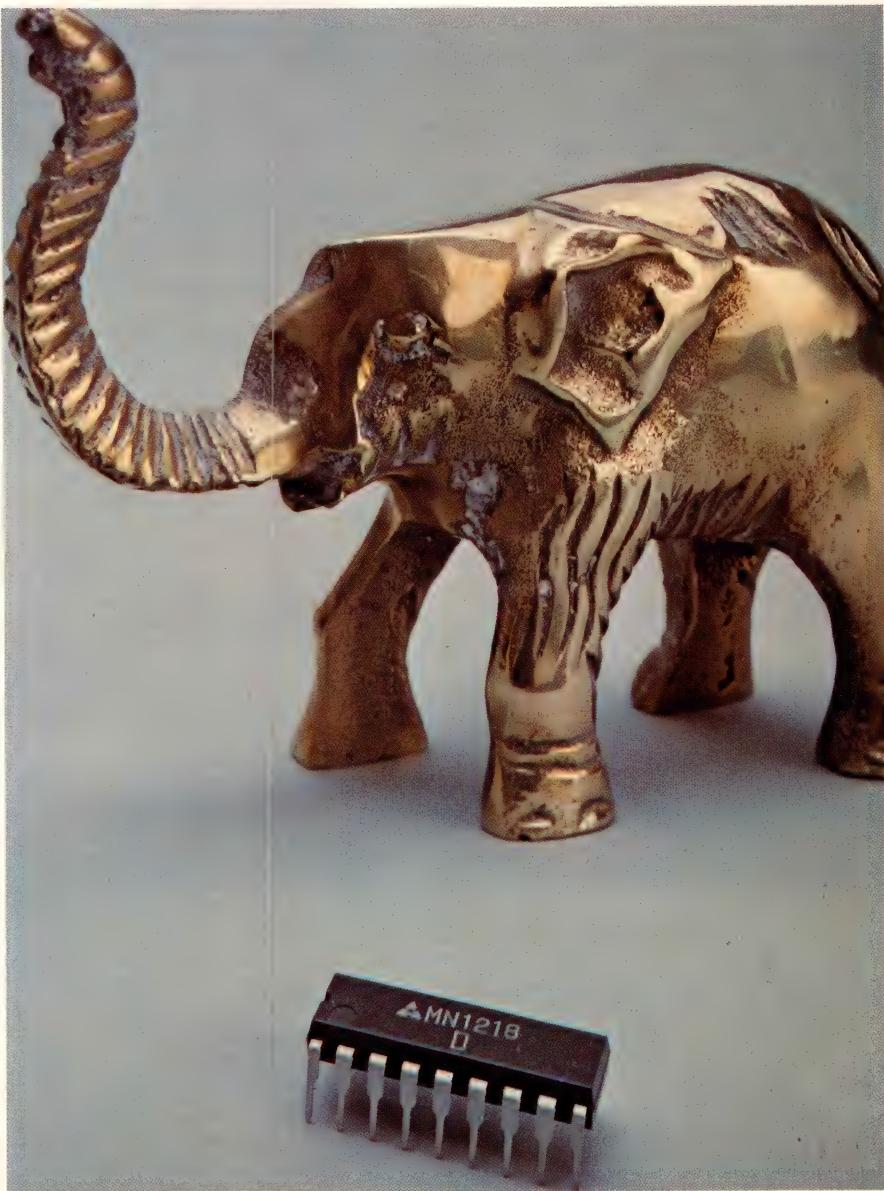
As improvements in memory devices continue unabated on every front, the latest and possibly most far-reaching advances concern nonvolatile memories such as electrically erasable PROMs (EEPROMs; also termed E²PROMs). Manufacturers developed these EEPROMs in their search for nonvolatile memories as easy to use as RAMs; many believe that these devices will replace ultraviolet-erasable units (UV EPROMs) by the middle to late 1980s.

Fabricated with floating gates in both NMOS and CMOS or employing improved MNOS (metall-nitride-oxide semiconductor) techniques, and in one case offering an innovative combination of RAM and EEPROM, these new devices feature fast access times, a virtually unlimited number of read cycles, much improved endurance (erase/write cycling) and longer data-retention times than their predecessors. Further improvements along these lines could ultimately yield a RAM-like nonvolatile memory.

μ Ps drive EEPROMs

The prime driving force behind memory development in the past has been μ P requirements. And although much of the push has concerned random-access memory, μ Ps also require some nonvolatile memory. This latter memory's form has continuously changed over the years, always tending to add more versatility for users.

Moving from mask-programmed ROM to fuse-link PROM to UV EPROM, programmable and reprogrammable memories have steadily progressed toward the ideal



Pushing data-retention time to 10 yrs, Panasonic's MN1218 (an updated version of the 1-yr-retention 1208) allows both word and bulk erasures and exhibits a typical endurance of 10^5 cycles. Not a slip-in replacement for the 1208, it needs ± 5 and $-28V$ supplies, and the separate 1-word memory now contains 16 bits instead of 12. However, the device still features separate 4-bit input and output buses, a 16×16 main memory and on-board address and control latches. Because it typically requires refreshing after 10^7 read cycles, it doesn't suit use as a RAM.

form—nonvolatile RAM. In the present generation of products, the popular UV EPROM is certainly field reprogrammable, but not while in circuit (except with difficulty).

MNOS-based memories, termed

EAROMs (electrically alterable ROMs), also belong in the EEPROM category. Available for a half-dozen years or so, these parts do permit in-circuit reprogramming. But several factors have

Technology News

restricted their acceptance to specialty applications. These factors include disadvantages such as high erase and write voltages with dual-polarity power supplies, complex voltage sequencing, a limited number of read cycles before refresh is required, and access times in the microsecond range.

Floating-gate performance

The latest EEPROMs change all that. The first of the floating-gate types to appear, the M 120, comes from Italy's SGS-ATES. A 256×4

CMOS device, it uses two control gates to erase and write to a polysilicon floating gate isolated by an easy-to-fabricate 1000Å oxide layer.

The double control gates allow you to alter individual bits while using only a 20V supply. When reading, the device needs only 5V and takes just 450 nsec for a read—incredibly fast for an EEPROM introduced in mid-1979. Write and erase times are much longer, but the chip incorporates the control and timing functions

necessary for these operations. In addition to input/output buffers, it includes address and control latches, an internal oscillator and read and modify timing circuits.

The M 120 takes 300 nsec to latch the input word for a modify operation, but it then floats its 4-bit bus and sends out a Busy signal, while a 2- to 100-msec modify sequence runs internally. To save time and power, the chip internally compares each input bit with its stored counterpart to determine whether modification is necessary. In this way, no cell is ever modified unnecessarily. At the end of the sequence, the memory reconnects to the bus and drops the Busy signal.

The device draws 300 mW in Read mode and 400 mW during a modification. Supplied in an 18-pin DIP, it exhibits an endurance of 10^4 cycles. SGS-ATES is also developing a 4k version of this memory.

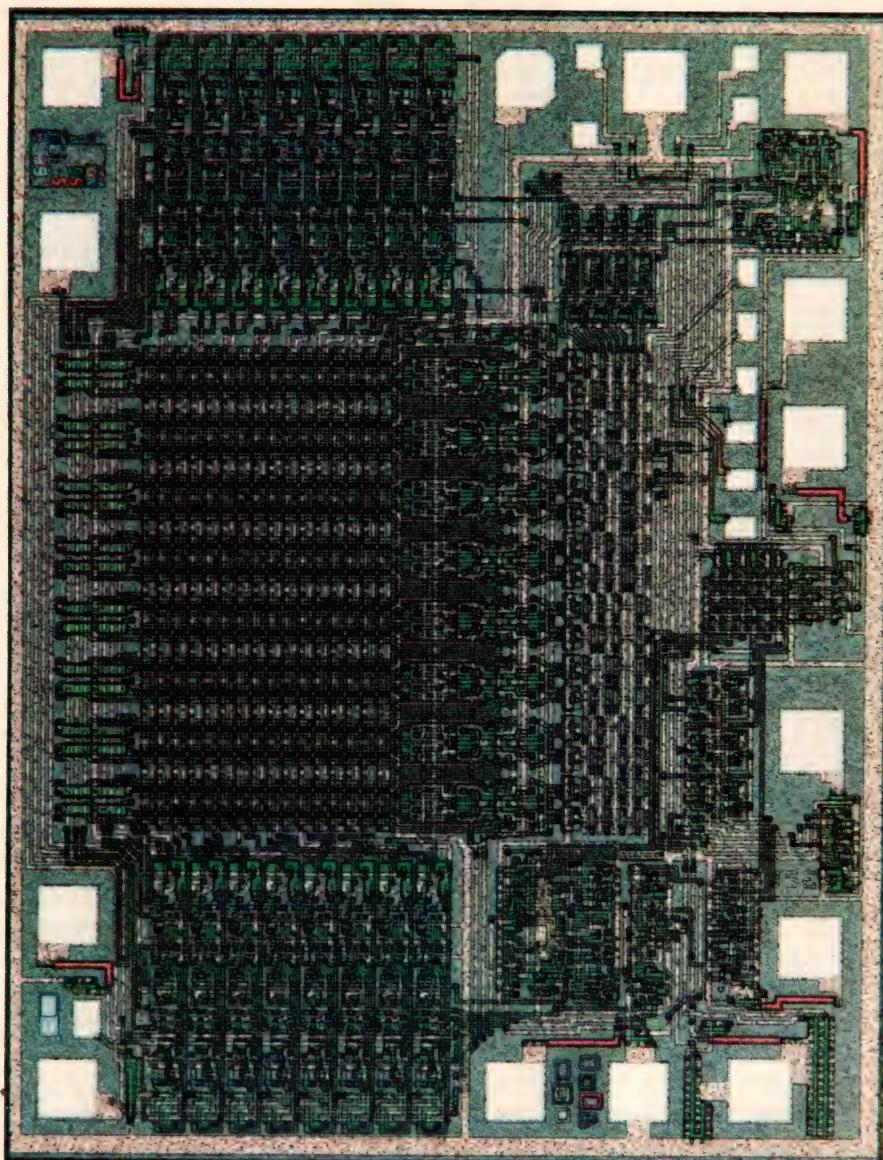
MNOS speeds up its act

Designating the HN48016 an EEPROM rather than an EAROM, Hitachi has introduced this first available 16k part. The device illustrates the capabilities that enable MNOS EEPROMs to stay competitive with their NMOS and CMOS counterparts.

The 48016 is built with an n-channel silicon-gate process instead of the slower p-channel aluminum-gate fabrication method used for earlier EAROMs. This new process brings its access time down to 350 nsec max, 250 nsec typ.

Pin compatible with the 2716 UV EPROM, the 2k×8 unit requires the same voltages—5V for read and 5V and 25V for programming or erasure. Programming takes 10 msec/byte, but erasure requires a 1-sec pulse and clears the entire memory. Endurance conservatively rates at 10^3 cycles, while data retention is greater than 10 yrs. The part is available now at a very competitive price of \$57 (100).

General Instrument—a pioneer in



Starting out small, the MCM2801 256-bit EEPROM is Motorola's first entry in the field. But the firm plans to offer a 16k device soon and additional densities later. Organized as 16×16 with serial input and output, the device requires a 5V supply for a read and a 25V supply for programming. A 3-bit parallel instruction bus controls the part, which normally draws 30 mA but needs only 300 μA in Standby mode.

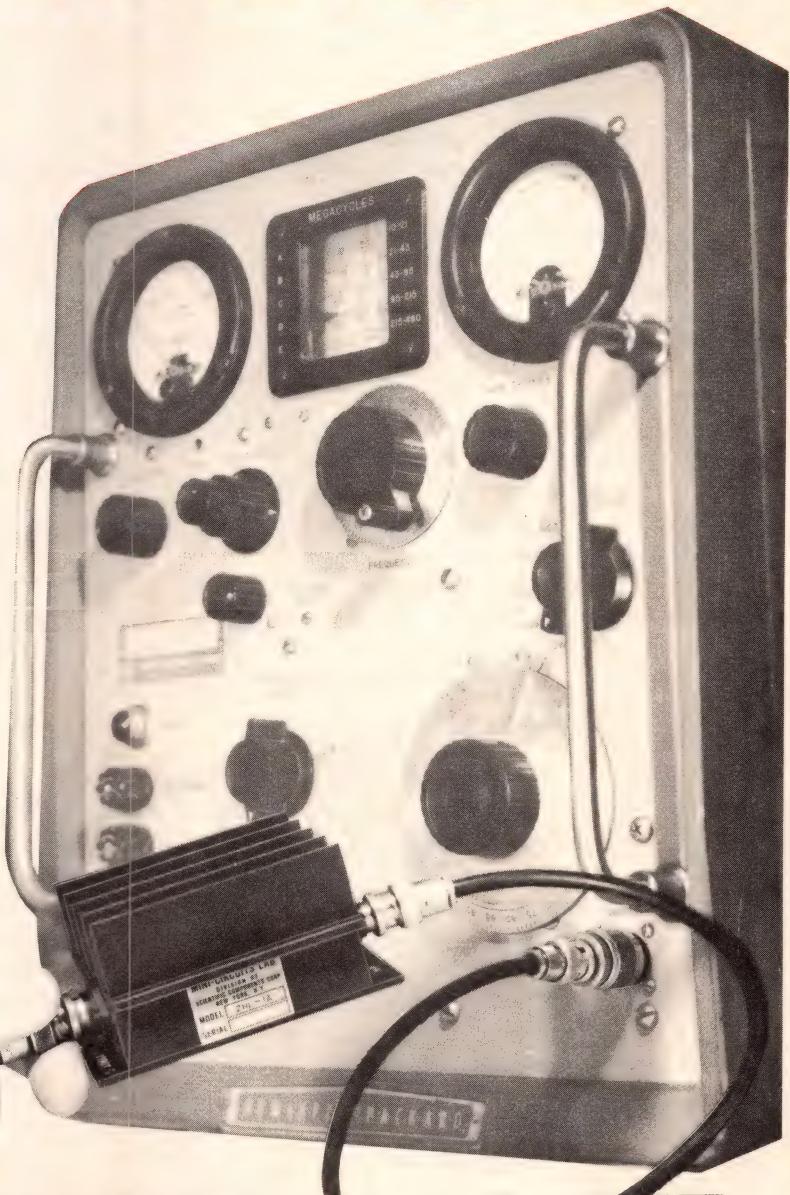
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the EEPROM field and a high-volume user of p-channel metal-gate MNOS—is also getting into the n-channel business to obtain devices with shorter read times. The firm is sticking with the metal-gate approach, however.

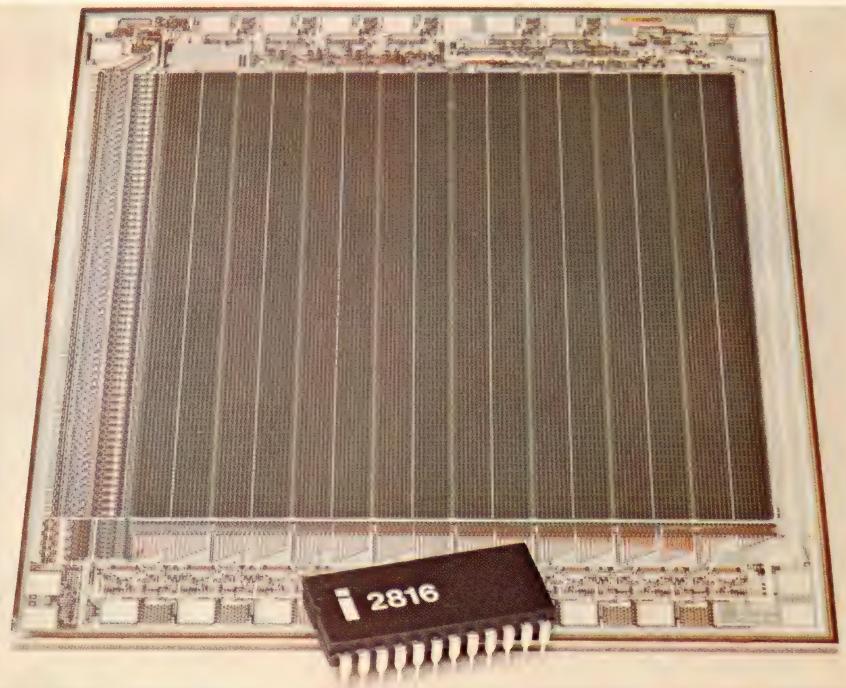
GI's ER4201 features a 128×8 -bit configuration, 5V read, 24V write/erase without voltage sequencing, less than 350-nsec read time, 10- to 20-msec programming time and data-retention time greater than 10 yrs.

Moreover, the 4201 has some added functionality that makes it very easy to use—features that will doubtless appear in all manufacturers' future generations of EEPROMs. To relieve the peripheral hardware load, for example, the chip contains data, address and mode latches and timing circuitry and provides a Busy signal during write cycles. You can either word- or bulk-erase it, and an automatic erase/write-cycle command further eases μ P's control burden. Finally, an external RC network sets the internal frequency for erase/write times, furnishing a tradeoff between erase/write speed and data-retention time.

Although GI now makes 8k devices and is reportedly working on a 16k part, the company intends to serve what it sees as a significant market for small nonvolatile memories—a commitment reflected by the number of small memories in its catalog.

More firms enter the fray

Bypassing lower density parts altogether and advocating the floating-gate approach it terms Flotox, Intel is just getting into production with its Model 2816 16k EEPROM. A $2k \times 8$ design that conforms to the JEDEC byte-wide package standard, the part features a 250-nsec max access time that suits it for use with high-performance μ Ps without the necessity for Wait states. 200- and 350-nsec versions are also available.



Furnishing a 16k density, Intel's 2816 EEPROM is one of the largest such devices offered. Featuring a short (250-nsec) access time, it can interface with fast μ Ps without requiring Wait states. Two-line chip control eliminates contention between addresses and data on multiplexed bus lines.

Programmable on a byte-erase/write basis, the 2816 also permits bulk erasure. Erase/write time per byte and chip-erase time each equal 10 msec. Active power dissipation specs at 495 mW, but power in Standby mode drops to 132 mW. The device operates from a 5V supply in Read mode and requires a 21V pulse for writing and erasing.

The Intel part is typical of thin-oxide floating-gate cell structures that use Fowler-Nordheim tunneling (also termed cold electron injection) to achieve cell writing and erasure. Because this type of tunneling stresses the cell less than does avalanche injection (as with UV EPROMs), endurance increases by several orders of magnitude.

Impact on μ C-system design

As this and other approaches are refined, they will profoundly affect μ C-system design. Applications such as self-compensating or self-modifying process or numerical controllers, for example, will revolutionize the industrial market

and virtually every other one. EEPROM-based systems will permit you to phone in diagnostics and subsequent repair instructions or updated diagnostics as they are improved. Eventually, such systems could eliminate field calls by service people except in extreme cases.

As envisioned by Larry Jordan, strategic marketing and applications manager for Intel's Special Products Div, the combination of today's increasingly powerful μ Ps with EEPROMs starts a whole new chapter in the μ P story. The capability to dynamically reprogram a μ P on the fly will in itself open up an enormous application area, particularly in the field of robotics.

In error-correcting mainframe memory, EEPROMs allow dynamic mapping of good RAM over bad, thus eliminating many maintenance calls and reducing down time. And any application in which variables—such as tax rates in point-of-sale terminals and taxi-meter rates—

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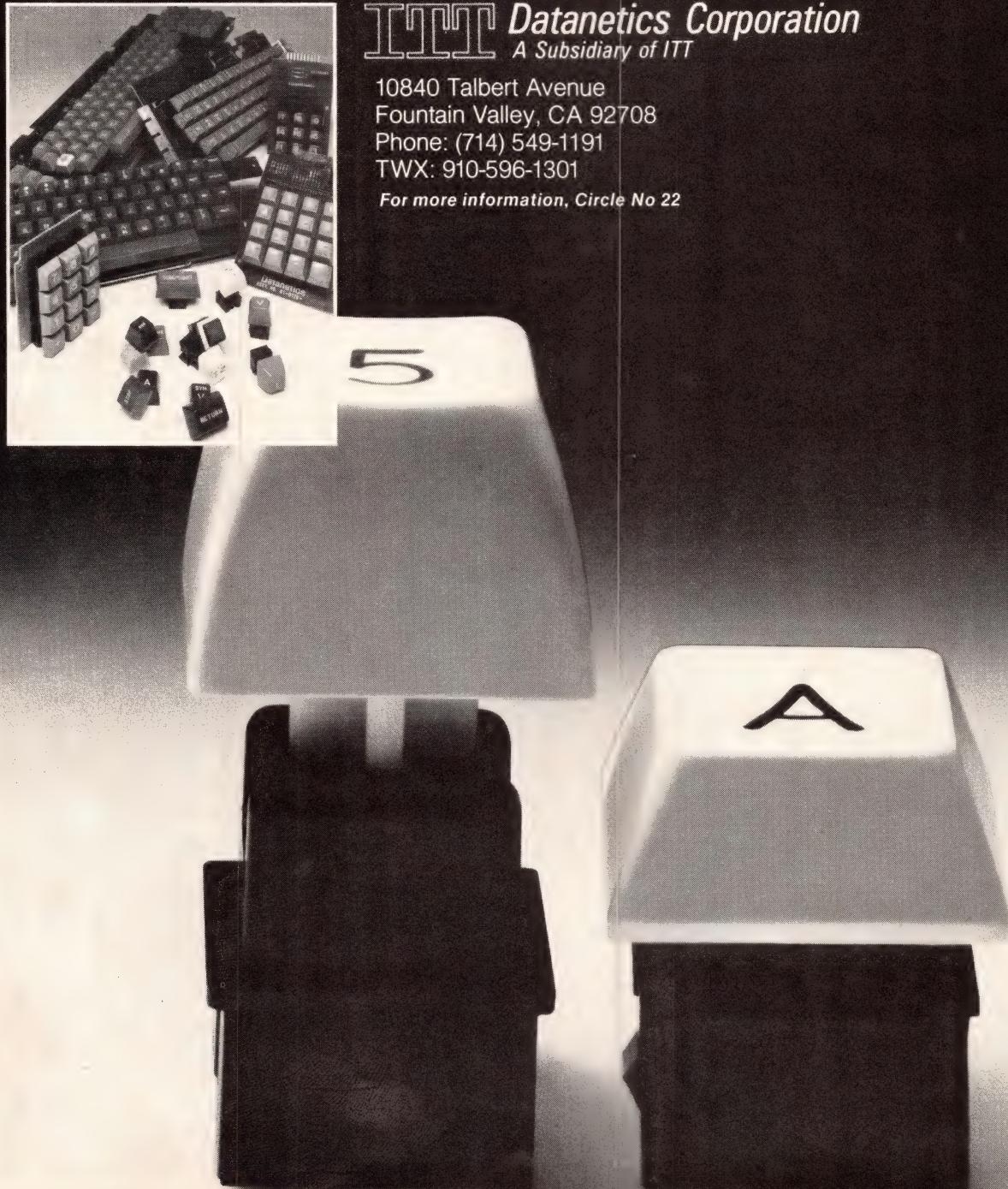
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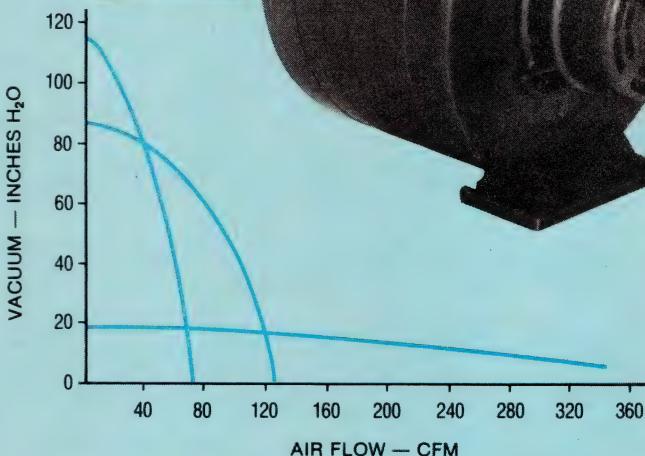
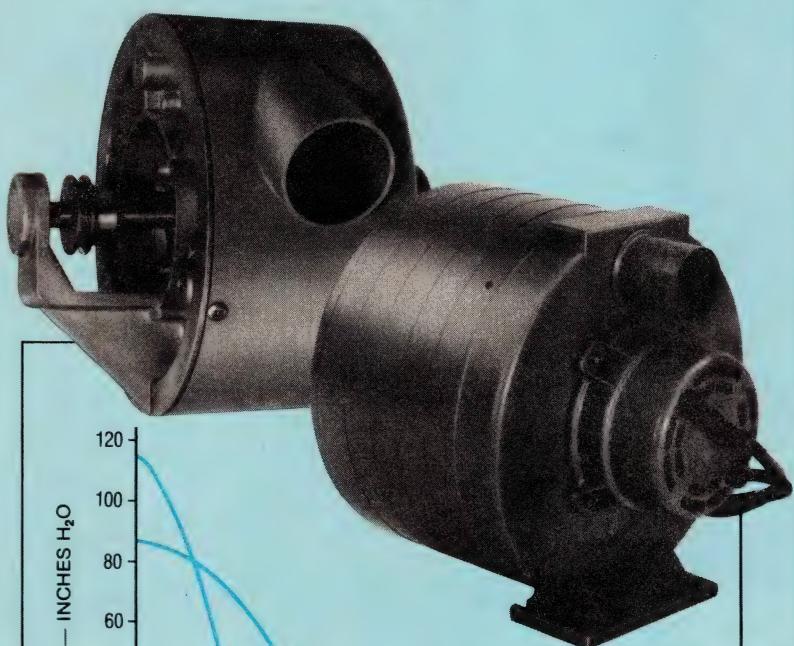
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change slowly (over weeks or years) will gain cost and time savings using EEPROM instead of UV EPROMs or fuse-link PROMs.

In military applications, the devices will permit in-flight target reprogramming of missiles, more secure encryption methods and navigational and radio-frequency changes via an umbilical cord rather than by removing sensitive memory cards.

Although Intel's 2816 cells employ both a storage and a select transistor, future designs will merge the two, producing a cell size no larger than that of a UV EPROM. And despite the several extra masking steps required to make EEPROMs, other factors, such as a cheaper package (no quartz window) and ease of testing (no 30-min-plus erase), will drive the devices' price down to the UV-EPROM level by the mid-'80s. In Jordan's opinion, the EEPROM will eventually (by 1990?) completely displace the UV EPROM. He also expects EEPROM speed and density specs to match those of current EPROM devices.

Additionally, in agreement with other EEPROM marketers such as Motorola's Dave Ford, Jordan expects to see the parts' functionality increase, thanks to added features such as power-supply switching, address and control latches and possibly programming-voltage bias generators. Many of these features already exist in MNOS devices produced by the more experienced companies in the business, but as newer manufacturers gain experience, they will doubtless add similar capabilities.

CMOS achieves 8k

One company already garnering the density advantages of merging an EEPROM's select and storage transistors is Hughes Aircraft with its 8k CMOS device. Among its outstanding features, the HNVM 3008 includes a 5V read voltage, a programming and erase voltage of

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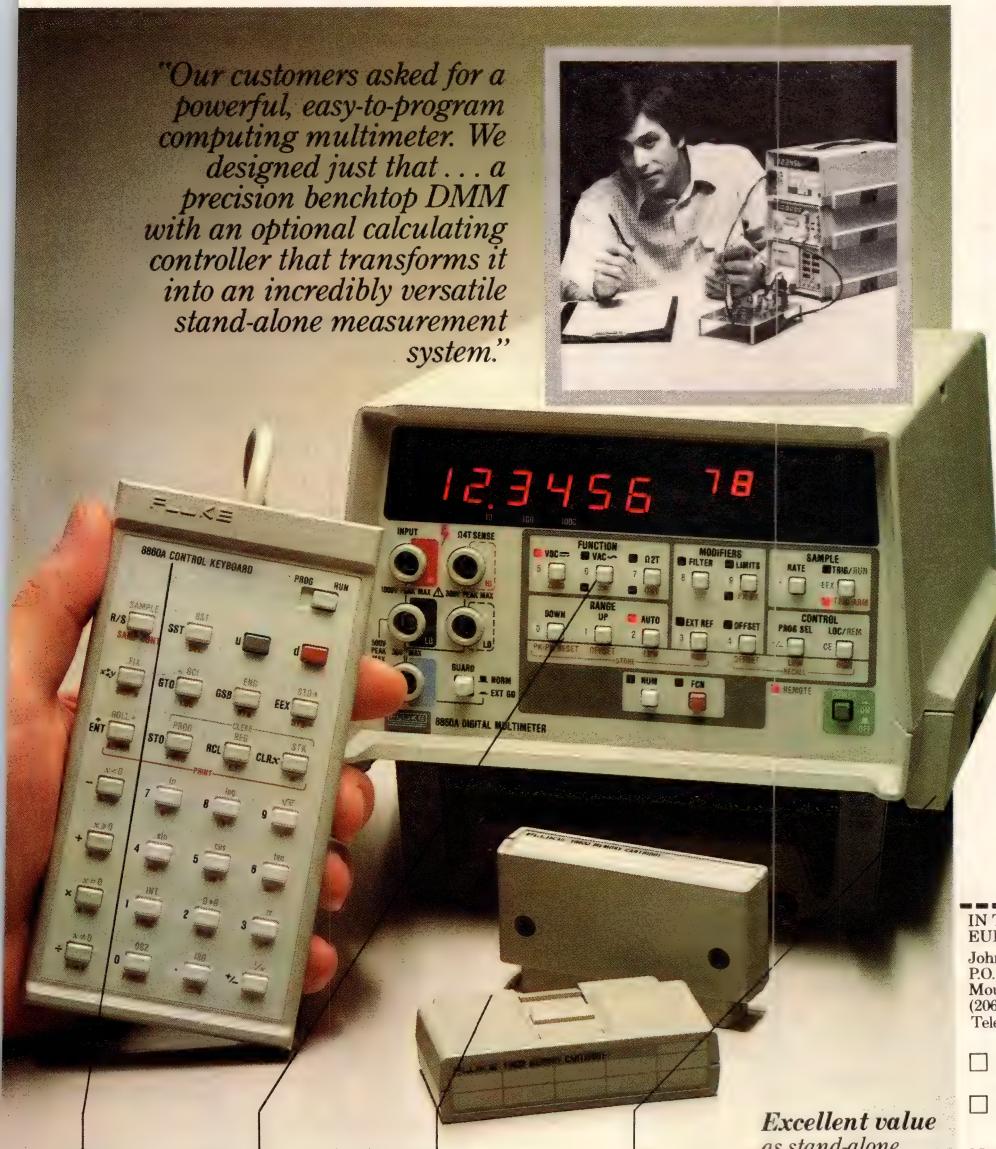
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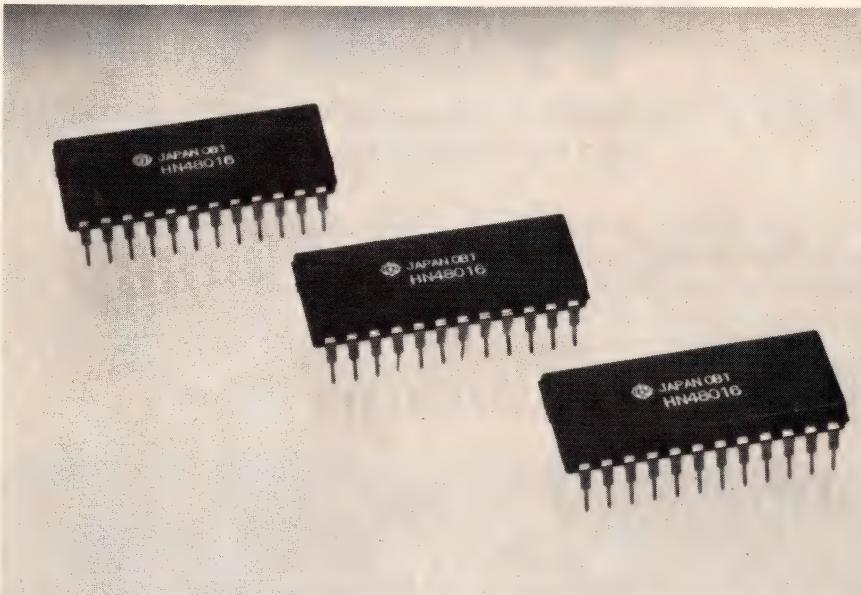
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Technology News



The first EEPROM to achieve 16k density, Hitachi's HN48016 is also one of the fastest devices available with a maximum access time of 350 nsec. The n-channel MNOS part requires 5V in Read mode and only one 25V supply for programming and erasure. Pin compatible with the 2716 EPROM, it block erases in 1 sec and programs at 10 msec/byte.

only 17V and a 5-mW typ operating power dissipation at 200 kHz; typical standby power drops to just 50 µW.

Configured as 1k×8 and using a floating silicon gate and thin tunneling oxide, the device bulk erases in 100 µsec, accesses in 500 nsec typ, programs at 100 µsec/byte, operates over -55 to +125°C and exhibits data retention of 10 yrs at 100°C and an estimated durability of 10⁵ cycles. The company also plans to produce a 512×8 version (HNVM 3004). The 3008 and 3004 cost \$300 and \$175, respectively, but Hughes expects prices to drop to less than \$50 before year's end.

Another company just entering the EEPROM market, Motorola now offers the 16×16 MCM2901. Reading a 16-bit word serially with this device takes 168 µsec, and an erase/write cycle requires 110 msec; reading calls for a 5V supply, while write/erase uses a 25V supply.

Utilizing a floating-gate structure, the 2801 is the forerunner of a 2816-type memory that the company will sample this quarter. Performance should be equivalent to that of the Intel part.

Mostek (Carrollton, TX) is in the early stages of definition for its proposed EEPROM, an NMOS device that might employ triple-level poly to produce a very small merged-transistor cell. Mostek presented a paper on the technology at last December's IEDM.

Small-scale MNOS

Although most of the manufacturers just entering the EEPROM field use the thin-oxide/floating-gate approach, the older MNOS technology is far from dead. Companies such as Nitron, Panasonic and Plessey are still adding p-channel MNOS products to their lines.

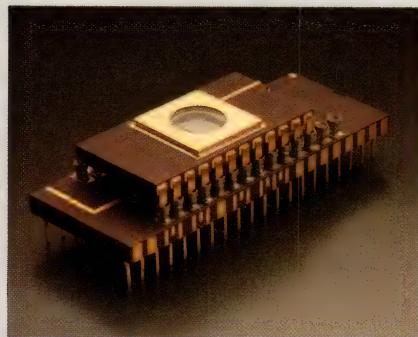
Nitron, for instance, recently introduced the NC7810, an alternative to NCR's 2k×8 NCR2810. Although the 7810 requires a -28V pulse for erasure, durability runs to 10⁵ cycles with a minimum of 2×10¹¹ read cycles before refresh. Price is approximately \$20 (100).

Sticking with smaller densities for now, Panasonic offers the MN1208, a 256-bit part with a 4-bit data bus and on-chip latches. Requiring -10 and -33V supplies, the \$5.75 (1000) device has a typical durability of 10⁵ cycles. Panasonic

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Now there is a practical alternative to a masked-ROM 8-bit microcomputer for low and medium volume applications: The MK38P70 from Mostek. It features a piggyback EPROM socket capable of accommodating industry standard 1K, 2K, or 4K X 8 EPROMs. Though the MK38P70 is an excellent prototyping tool, a recent, dramatic

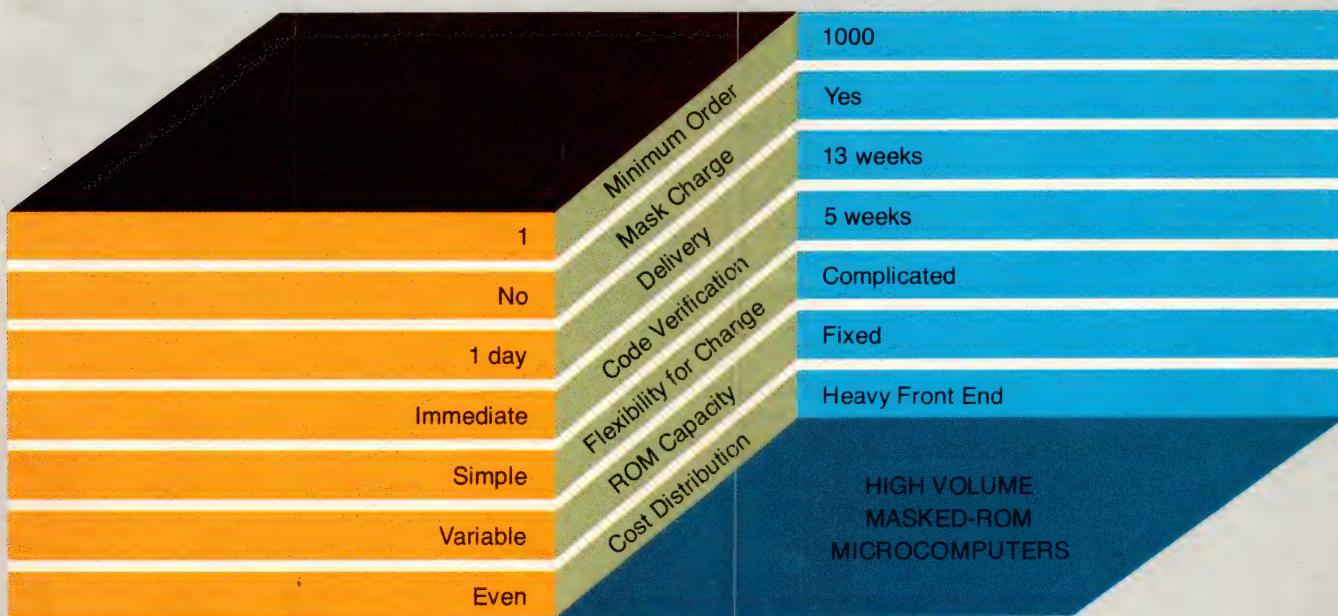
price reduction makes it highly efficient for production use as well. In fact, for low volume levels, the MK38P70 is now more economical than its masked-ROM counterparts.

For medium, or even high-volume levels, an EPROM-backed 3870 may still be your more efficient choice for production. Especially if time and flexibility are important. First, consider time. Delivery for the MK38P70 is off-the-shelf from your local Mostek distributor. And because it is an EPROM microcomputer, you can put it into production immediately.

Now consider flexibility. With the MK38P70, flexibility before, during or after system design is

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New EPROM Tester and Duplicator



The new UPP-2700 is now saving thousands of dollars for its owners by testing EPROMS both before and after programming. Many customers like Bell Labs, IBM, Litton and others have found the value of screening marginal EPROMS before they reach their end product.

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Technology News

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expects to introduce 1k and larger devices this year and sees no density restrictions in MNOS technology.

Plessey Semiconductor's latest EEPROM is also a 256-bit device, and it also features a 4-bit bus and data and address latches. The MN9210 furnishes a 1-yr data-retention time (as does the Panasonic part), operates over -40 to +70°C and costs \$28.69 (100).

NV-RAM ideal

All of the products described here are moving the memory art toward the ideal nonvolatile-RAM goal. And although EEPROMs don't quite merit that designation as yet, one product comes closer than the others.

The X2201 from Xicor combines a fast standard RAM with a floating-gate EEPROM in an exceptionally easy-to-use 1k×1 memory. The RAM portion accesses in less than 250 nsec typ, and the entire memory transfers to EEPROM in one snapshot operation requiring less than 5 msec. Recall

from storage to RAM requires less than 1 μsec, and both operations employ a simple TTL signal for initiation.

This part's key advantage, however, is its use of a single 5V supply for all operations. The chip generates its own tunneling voltages, eliminating the need for multiple supplies. Additionally, once a store operation begins, you can access the contents of the foreground RAM normally, causing no μP waits. The X2201 permits an unlimited number of reads, and endurance specs at 10³ to 10⁵ cycles.

At present, the device's main problems center on density and price: It comes only in a 1k version priced at \$25 (1000), but Xicor expects to reduce the price to \$10 by late this year and introduce a 4k model at about the same time.

Meanwhile, the X2201 remains probably the best choice for a power-fail memory because of its speed of transferral. And—if your application warrants the price—it's the easiest to use nonvolatile memory on the market.

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Helping keep software costs down must be counted as one of the MC6809's greatest assets. Its software-oriented architecture permits programmers to spend less time learning, more time programming. High-level languages like Pascal help keep costs down, too. And with the position independent addressing modes of the MC6809, standard "Software on Silicon" modules can be created to eliminate countless rewritings of commonly used codes.

Architectural advantages, beyond 16-bit registers and modern programming techniques, add to the versatility and cost-effectiveness of the MC6809. Auto-increment and auto-decrement addressing modes improve the efficiency of block moves and string handling, and extensive stack manipulation capabilities make block-structured high-level languages a natural.

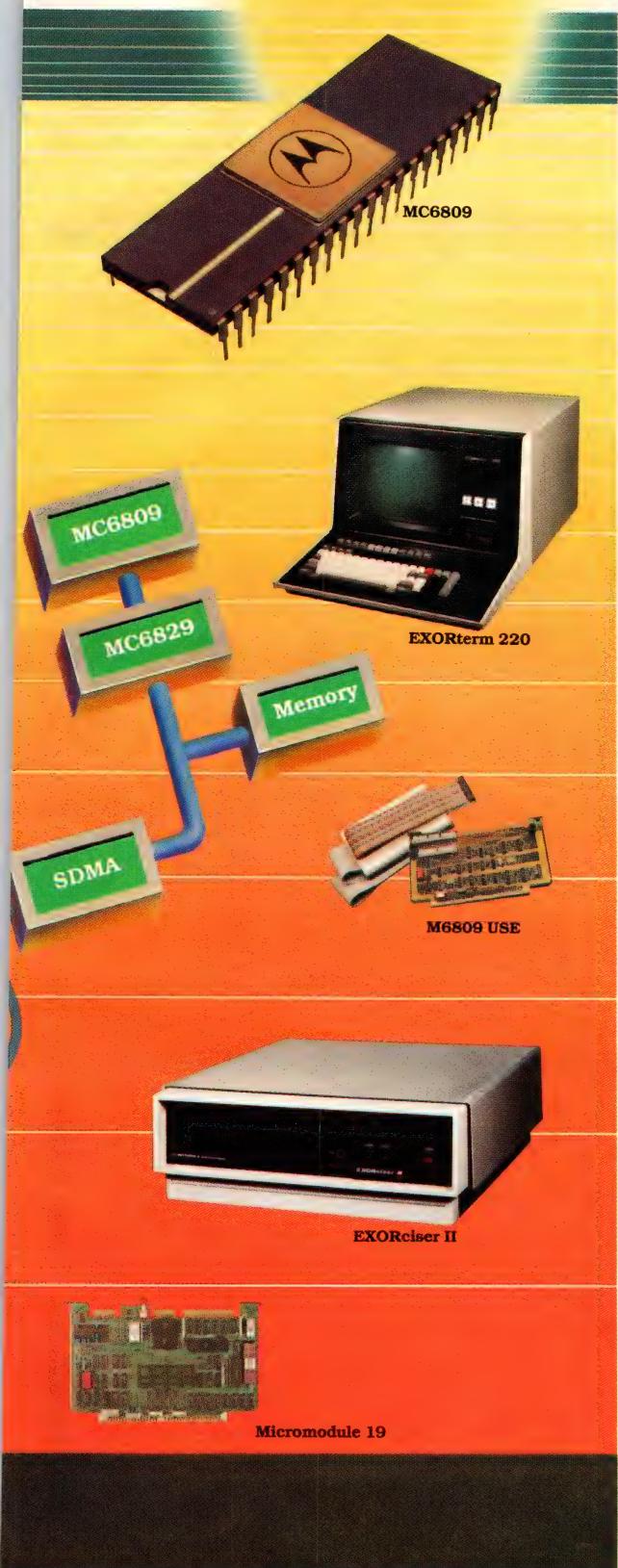
The M6809 Family plan for advanced systems.

A whole new family of VLSI peripherals has been designed to take advantage of the many powerful features of the MC6809, and in turn, to help users obtain its full potential in flexible, high-performance 8-bit and pseudo 16-bit systems.

System support for the MC6809 is still supplied by the entire complement of M6800 Family peripherals, and several of the high-performance VLSI peripherals of the 16-bit M68000 Family also are directly compatible.



high-performance MC6809 advanced 8-bit systems.



Coprocessing is easily accomplished with the MC6809 Family. The new externally clocked MC6809E provides the flexibility required for multiprocessing: multiple processors operating in parallel on the same bus. Unlike some coprocessing schemes, with the MC6809E users are not limited only to floating point or string manipulations.

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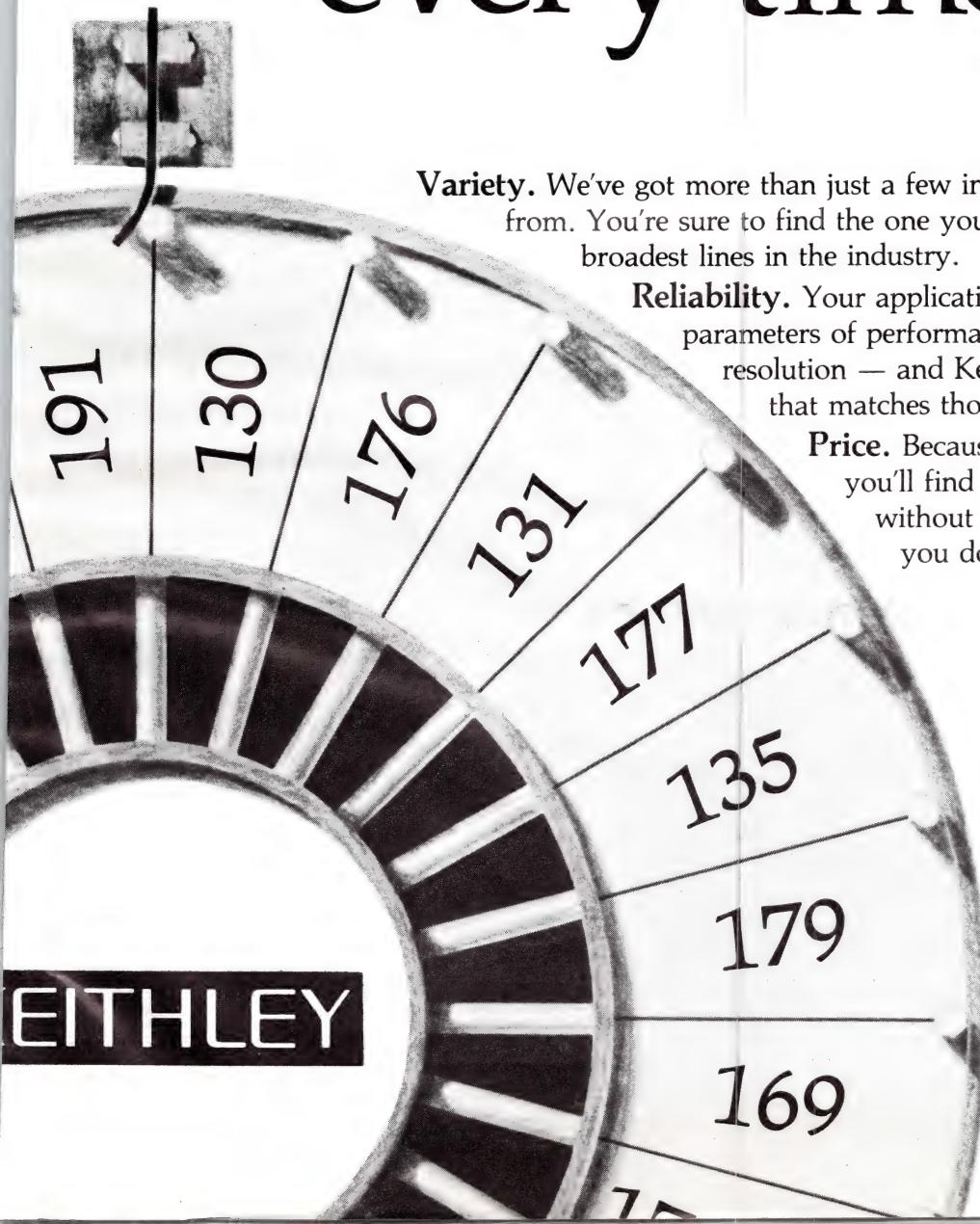
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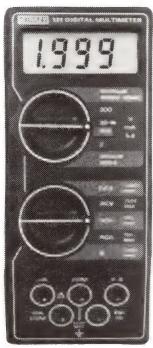
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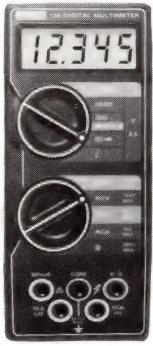
\$115



Model 131: 0.25% accuracy.

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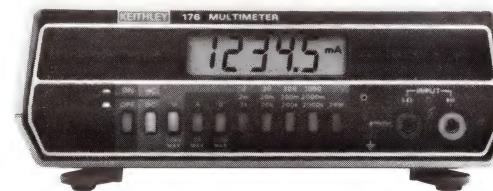
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\$169
With battery eliminator **\$199**



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\$249

With battery eliminator **\$279**

MODEL	130	131	135	169	176
Digits	3½	3½	4½	3½	4½
DCV Sensitivity	100µV	100µV	100µV	100µV	100µV
Accuracy	0.5%	0.25%	0.05%	0.25%	0.05%
ACV Sensitivity	100µV	100µV	100µV	100µV	100µV
Accuracy	1%	1%	1%	0.75%	1%
DCA Sensitivity	1µA	1µA	10µA	100nA	1µA
Accuracy	1%	0.75%	0.5%	0.75%	0.5%
ACA Sensitivity	1µA	1µA	10µA	100nA	1µA
Accuracy	2%	2%	1.5%	1.5%	1.5%
OHMS Sensitivity	100mΩ	100mΩ	100mΩ	100mΩ	100mΩ
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PRICE	\$115	\$134	\$219	\$169	\$249

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\$595

MODEL	178	179*	179-20A*	177*	191
Digits	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$	$5\frac{1}{2}$
DCV	Sensitivity Accuracy	$100\mu V$ 0.04%	$10\mu V$ 0.04%	$10\mu V$ 0.04%	$1\mu V$ 0.03%
ACV	Sensitivity Accuracy	$100\mu V$ 0.3%	$10\mu V$ 0.5%	$10\mu V$ 0.5%	[†] $10\mu V$ 0.1%
DCA	Sensitivity Accuracy	— —	$10nA$ 0.2%	$10nA$ 0.2%	1nA 0.2%
ACA	Sensitivity Accuracy	— —	$10nA$ 1%	$10nA$ 1%	10nA 0.8%
OHMS	Sensitivity Accuracy	$100m\Omega$ 0.04%	$100m\Omega$ 0.04%	$100m\Omega$ 0.04%	$1m\Omega$ 0.04%
PRICE	\$249	\$329	\$395	\$449	\$595

*IEEE-488 Interfaceable

[†]Optional

Interfaceable—now or later.

The Keithley 488 line of interfaceable DMMs can solve your budget and measurement problems, because you can build an automated IEEE-488 bus system at a lower price than ever before. The optional interface is easily field-installed with a screwdriver, and is powered from the instrument's normal power cord. Whether you decide to interface now or later, you still receive maximum value. A high-quality basic Keithley DMM is a fraction of the cost of competitive IEEE-488 compatible DMMs. And the IEEE-488 bus interface can be added at any time for less than the cost of the original unit. With Keithley, you buy only what you need, when you need it. The Isolated IEEE-488 Output is for Models 177, 179 and 179-20A.

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Model 1600: High Voltage Probe (40kV)	\$125
Model 1651: 50-Ampere Current Shunt	\$50
Model 1681: Clip-On Test Lead Set (48 in.)	\$6

Model 1682: RF Probe	\$170
Model 1683: Universal Test Lead Kit with 14 tips	\$10
Model 1684: Hard Shell Carrying Case with foam insert	\$40
Model 1685: Clamp-On AC Current Probe	\$75
Model 1691: General Purpose Test Lead Set	\$6

Other DMM Accessories

MODEL	130 & 131		135	169	176	178	179 & 179-20A		177	191
	Std.	Std.	Std.	1768*	1788	1788	1788	1788	1788	1788
Battery Pack	Std.	Std.	Std.	1768*	1788	1788	1788	1788	1788	
BCD Output						1792	1792			
IEEE Interface						1793	1793			
Spare Parts Kit	1309	1359	1699	1769	1789	1789	1789	1779	1919	
Battery Eliminator			1766	1766						
Carrying Case	1304	1304	1684	1684	1684	1684	1684	1684	1684	1684
Calibration Cover									1913	
Kelvin Leads										1641

*Battery operation is standard on Model 176; 1768 option converts Model 176/1766 (ordered with 1766 Battery Eliminator installed) to battery operation.

Model 1304: Soft Carrying Case & Stand	\$10	Model 1779: Spare Parts Kit	\$75
Model 1309: Spare Parts Kit	\$30	Model 1788: Rechargeable Battery Pack	\$79
Model 1359: Spare Parts Kit	\$30	Model 1789: Spare Parts Kit	\$85
Model 1641: Kelvin Test Leads	\$99	Model 1792: Isolated BCD Output	\$165
Model 1699: Spare Parts Kit	\$35	Model 1793: Isolated IEEE-488 Output	\$295
Model 1766: Battery Eliminator	\$40	Model 1910: AC Volts Option	\$175
Model 1768: Battery Pack	\$40	Model 1913: Calibration Cover	\$35
Model 1769: Spare Parts Kit	\$30	Model 1919: Spare Parts Kit	\$85

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Technology News

Use Navy calibration-system spadework to configure your own calibrators

Andy Santoni, Western Editor

A US Navy-developed system for calibrating shipboard test equipment is bringing to the commercial instrument market a series of "modules" that, although built by different suppliers, can work together easily to calibrate a wide variety of instruments. Housed in portable cases for use in the Navy program, the Series's IEEE-488-bus controller and most of the modules for calibrating oscilloscopes, multimeters, counters and signal generators are also available (or will be) in rack-mounting versions for stationary systems.

New modules join old

In the 6 yrs the Navy's Modularly Equipped and Configured Calibrators (MECCA) program has been in development, four pieces of the system have been designed and made commercially available:

- The bus controller, currently a version of Fluke's Model 1720A
- The frequency-counter calibrator, ArgoSystems' Model AS 210
- The multimeter calibrator, a version of Fluke's Model 5100B
- The oscilloscope calibrator, at present a version of Tektronix's Model CG 551AP.

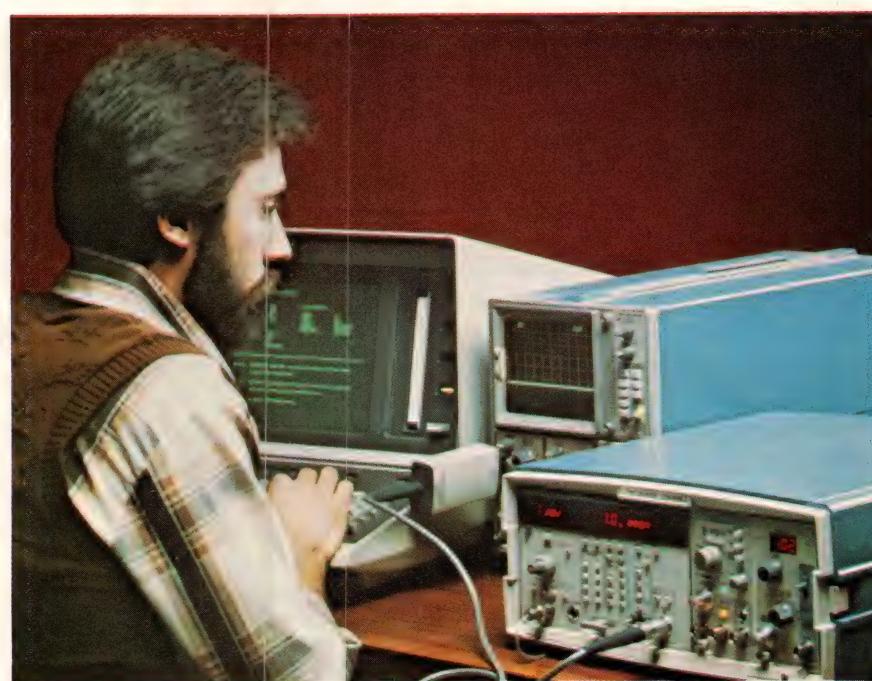
An earlier MECCA IEEE-488-bus controller was produced by Instrumentation Technology Corp, which has since gone out of business.

This year, three new modules will join the family:

- A higher accuracy multimeter calibrator, derived from Fluke's Model 8502A
- A signal-generator calibrator, based on Weinschel Engineering's Model VM-4A
- A second scope calibrator, derived from Ballantine Labo-



The master controller for the Navy's MECCA calibration system is Fluke's Model 1720A, although you can use other IEEE-488 controllers as well in the commercial version of the system.



Prompting software helps you write calibration-procedure programs for Tektronix's Model CG 551AP scope calibrator.

Technology News



More than 80% of the Navy's needs for DVM and DMM calibration are met by a modified version of this Fluke Model 5100B.



A rubidium standard is at the heart of ArgoSystems' frequency-counter calibration set. Its 10-MHz output goes to all the plug-ins in the portable mainframe.

ratories' Model 6125C.

All these products aim to reduce the cost of calibrating precision instrumentation. In the Navy's case, savings result from portability and ease of use, explains Peter Strucker, supervisor of electronics engineering and branch head of the Advanced System Development Group at the Navy's Metrology Engineering Center (Pomona, CA). (The center is operated for the Navy by General Dynamics Corp.)

MECCA's largest payoff has been in calibrating shipboard instruments, continues Strucker. Portability allows technicians to bring calibrators aboard ship while in port, rather than bringing the instruments ashore for calibration. In addition to reducing turnaround time, this shipboard calibration eliminates the potential of damage or misalignment resulting from such a move. Better yet, the calibration technique eliminates the chance of the ship's sailing before all calibrations are completed and all instruments returned.

Because the equipment is easier to use than manual calibration gear, technicians can operate it with less training, says Strucker. This feature is especially important aboard ship, where rotation of personnel often calls for continuous retraining.

Controller uses touch CRT

Disk-based software and a touch-sensitive CRT screen provide the Fluke Model 1720A controller

with its ease of use. (In the earlier Instrumentation Technology controller, a tape drive and plasma-panel display were configured to provide the same features.) In its commercial version, the controller costs \$8900 or more and includes a floppy-disk drive, 24k bytes of RAM available for user programs and an "electronic disk"—a file-structured semiconductor memory that stores 128k or 256k bytes of data from the floppy. This unit functions as working memory to speed file access, permit disk duplication and increase reliability.

The controller's touch-screen CRT display allows an operator to run an instrument system without using a keyboard and thus prevents operators from making unauthorized software changes. Prompting software provides graphics-generated boxes on the screen so the operator need only touch the screen to make a choice—like checking off the correct box on a multiple-choice test.

Naturally, because the other modules in the MECCA system are controlled over the standard IEEE-488 bus, you can also use other units, from interface boards to complete computer systems, as bus controllers for MECCA configurations. However, such systems sacrifice Model 1720A's touch-screen control and perhaps other features as well. (For a description of available IEEE-488-bus control hardware, see EDN, November 5, 1980, pg 69.)

The key to a MECCA system, though, is the calibration-procedure software: MECCA's operating system provides a learning mode and a running mode. Procedure disks contain instructions for calibrating specific instruments with step-by-step, hand-holding directions for less skilled technicians and less explicit directions for experienced operators.

Strucker explains that beginners need detailed directions to avoid making errors, whereas well-trained technicians need less prompting; otherwise they grow bored. "Some users don't like complete automation," he says, adding that they want to have something to do so they can feel that they're part of the operation.

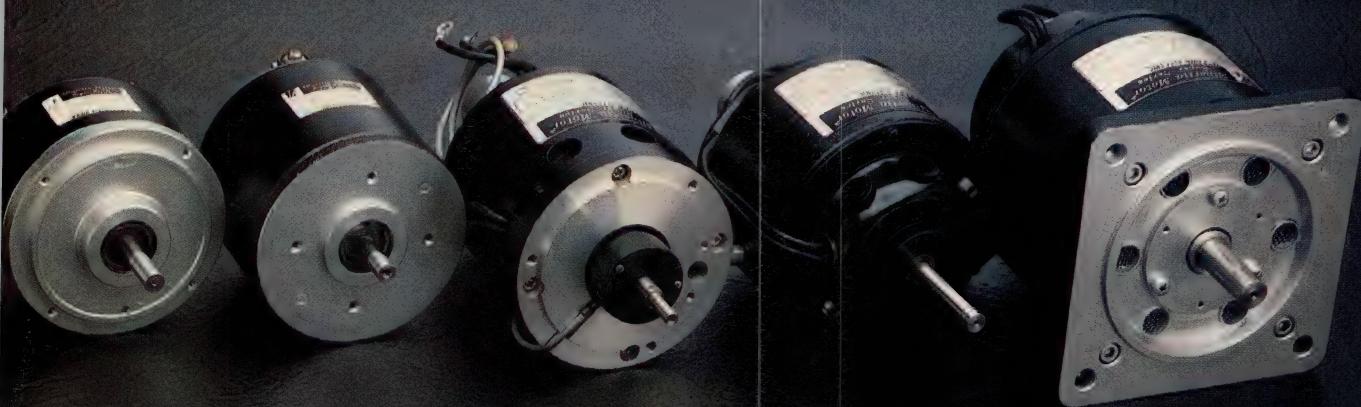
Good tryout results

MECCA hardware and software have been in the field for about 1 yr now, and with more than 50 systems in operation, notes Strucker, the equipment has proven itself effective, even though some learning is still required.

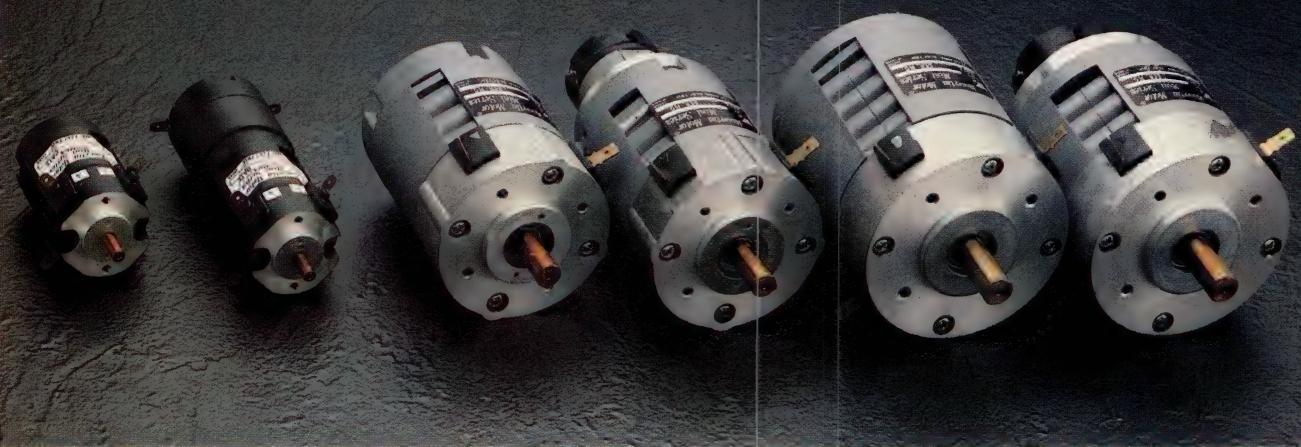
The alternative to a MECCA system (see box, "Calibration-system alternatives") is a manual one operated by a qualified technician—a person becoming increasingly difficult to find and pay, says Thomas O'Brien, program manager in the Systems Analysis Group at ArgoSystems. And especially in frequency-counter calibration, the alternatives are usually not portable, require

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Technology News

lengthy warmup and manual calculation of such important factors as drift rate, and ignore important parts of the calibration procedure, (such as sensitivity testing) while concentrating on accuracy.

ArgoSystems' MECCA Model AS 210, though, comes in a portable carrying case and weighs only 26 lbs, warms up to a frequency offset less than one part in 10^{10} in less than 10 min, can calculate drift rate per year, day or hour, and provides accurate frequency and level outputs for testing amplitude sensitivity.

The \$26,845 AS 210 system (mainframe plus five plug-ins) is housed in a Tektronix Model TM 515 mainframe that ArgoSystems has extensively modified. In it, the TM 515's power supply and backplane are replaced with a module that combines a new power supply and backplane with a rubidium frequency standard. The new backplane assembly distributes the 10-MHz standard frequency, power and control signals and is designed with connectors offset from the TM 515's connector positions so that a user can't plug in the wrong modules.

Rb standard fixes frequency

The rubidium standard in the \$10,335 AS 210 mainframe uses a higher propagation mode than most similar devices from Hewlett-Packard Co and other sources. Thus, it achieves smaller size. The tradeoff lies in accuracy: This parameter lies within 3×10^{-11} frequency retrace after turn-on for the AS 210, compared with better than 2×10^{-12} for HP's \$9250 Model 5065A rubidium frequency standard, for example.

Another part of the AS 210 configuration is the \$3990 Model AS 210-01, a dual-width μ P-based plug-in controller for the AS 210 system, programmable through its front panel or over the IEEE-488 bus. Built-in drift-rate-calculation programs produce per-hour, -day or -year calculations and display those

values on the front panel.

A Self Test mode checks not only the controller's major operating parameters, but also those of other installed plug-ins. Battery backup

for the unit's real-time clock and RAM is included.

Model AS 210-02 (\$2190), another piece of the ArgoSystems frequency-calibrator module, is a single-

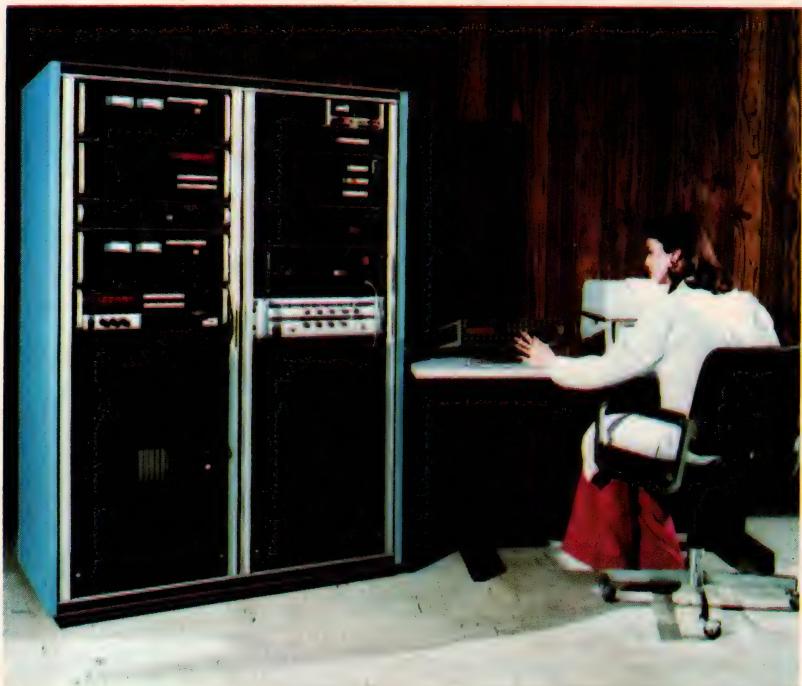
Calibration-system alternatives

Although taking advantage of the Navy's development work and buying similar equipment for your calibration requirements might offer the advantages of portability, programmability, compatibility and relatively low cost, other approaches to calibration might be more appropriate for your needs.

You must decide, for example, whether your instruments need the precision and versatility available with MECCA calibration equipment. Otherwise, you could be better off with lower cost equipment, such as Data Precision's \$1595 Model 8200 voltage calibrator or Global Specialties' \$225 Model 4401 frequency standard.

On the other hand, you might need even higher precision than MECCA components can achieve. In that case, you could look into equipment such as Hewlett-Packard's Model 5061A Option 004 cesium-beam atomic frequency standard, a \$23,700 instrument with accuracy of $\pm 7 \times 10^{-12}$, or Ballantine Laboratories' Model 1600A automatic balancing ac/dc transfer standard, a \$5295 instrument with 5-Hz to 30-MHz frequency range and 0.01% basic accuracy.

As part of this latter approach, you can buy precision voltage dividers, standard voltage cells and potentiometers from Julie Research Laboratories. And if you don't want to design your own calibration system, you can also obtain turnkey automated calibration systems from Julie Research or from Fluke.



Turnkey automatic calibration systems like this Julie Research Locost 106 provide an alternative to designing your own calibration equipment.

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Technology News

width plug-in that lets you compare the frequency of the internal standard with those of as many as six external sources. You can store up to 500 samples for computing warmup, drift-rate and aging characteristics. And Model AS 210-03 (\$4445), a single-width plug-in frequency generator, operates over 1 to 500 MHz and a 60-dB dynamic range. Its output-level accuracy lies within 10% to 300 MHz and within 15% at 400 or 500 MHz.

A digital-delay generator, the \$3990 Model AS 210-04 provides a selectable time interval between a reference pulse and a delayed pulse. Its outputs can produce -2.5V to +2.5V into 50Ω with rise and fall times less than 3 nsec. Finally, Model AS 210-05 (\$1895) is a battery pack and recharger that provides at least 3 hrs of standby power (which can be required in precision frequency measurements where low ac-line voltages or dropouts are a severe problem).

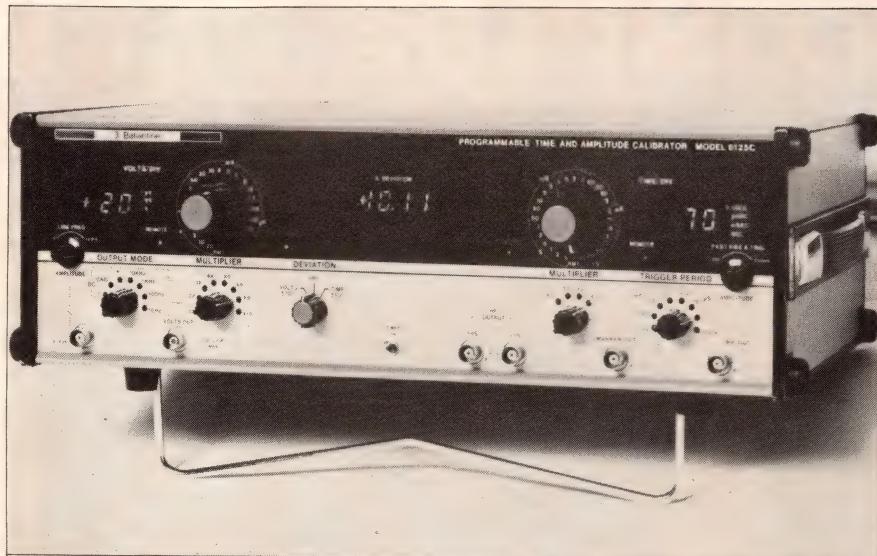
DMM calibrator meets most needs

Other elements of the MECCA system are equally versatile. For example, for calibrating DMMs, the modified Fluke 5100B meets 80% of the Navy's needs, says Strucker. And Fluke should have a higher accuracy DMM calibrator with true-rms capability this year to meet the other 20%.

The \$7495 Model 5100B provides sources for dc and ac voltage and current as well as resistance. It can calibrate devices ranging in complexity from 1-function panel meters to autoranging multimeters with resolution as high as $4\frac{1}{2}$ digits.

The instrument's μ P can calculate whether an instrument under test is within tolerance, no matter what form you use to express tolerance: volts, amps, ohms, decibels or percent. IEEE-488 and RS-232C interfaces cost \$400 each.

Model 5100B features basic dc accuracy of $\pm(0.005\%$ of setting + 0.001% of range + 5 μ V) and ac-voltage accuracy of $\pm(0.05\%$



In the second round of MECCA procurements, the Navy selected a modified version of Ballantine Laboratories' Model 6125C as a scope calibrator.

of setting + 0.005% of range + 50 μ V) from 50 Hz to 10 kHz and $\pm(0.08\%$ of setting + 0.008% of range + 50 μ V) from 10 kHz to 50 kHz. Accuracy on dc-current ranges is $\pm(0.025\%$ of setting + 0.0025% of range + 0.01 μ A), and it's $\pm(0.07\%$ of setting + 0.01% of range + 2 μ A) on ac-current ranges. Finally, accuracy equals $\pm 0.005\%$ on most resistance ranges. A \$1500 wide-band option broadens the ac frequency range to 10 Hz at the low end and 10 MHz at the high end.

Scope cal also grows easier

The standard MECCA scope calibrator is a version of Tektronix's Model CG 551AP, although a follow-on order has gone to Ballantine Labs for a version of its \$5950 Model 6125C time and amplitude test set with IEEE-488-interface option. The \$12,000 Tektronix instrument, a 3-wide plug-in for the firm's TM 500 Series mainframes, won't plug into ArgoSystems' modified case but will work in any of Tektronix's standard cases, including the \$380 portable model.

This calibrator checks an oscilloscope's vertical gain, horizontal timing and gain, vertical bandwidth and pulse characteristics, probe

accuracy and compensation, current-probe accuracy and calibrator-output accuracy. And along with governing operator actions and generating calibration signals, Model CG 551AP's software can take over many measurements of oscilloscope error and comparisons with the user's permissible standards. A Scope Cal Procedure Development Aid Program simplifies generating calibration programs by prompting a technician to set up the instrument's front panel for each test condition; it also learns these settings to generate the test program.

The MECCA scope calibrator from Ballantine offers amplitudes from 30 μ V to 220V ac and 300 μ V to 220V dc as well as four crystal-controlled standard square-wave frequencies from 10 Hz to 10 kHz to check oscilloscope amplitude, attenuator compensation, scope and frequency-counter trigger sensitivity and voltmeter accuracy. In the Amplitude Deviation mode, you can vary the output amplitude until the square wave aligns with the graticule marks on the scope under test, then read the scope deflection error on the calibrator's LED display with a resolution of 0.01% over a 10%

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For complete technical data, write for Engineering Bulletin 4710B to Technical Literature Service, Sprague Electric Co., 491 Marshall St., North Adams, Mass. 01247.

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deviation range.

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Sig-gen calibrator coming

The final piece of the MECCA system currently in the works is a signal-generator calibration package from Weinschel Engineering. The instrument, scheduled for delivery to the Navy this year and to be available as a commercial product in 1982, is based on Weinschel's \$65,000 Model VM-4A μ P-controlled dual-channel receiver, with frequency counter, power meter and modulation analyzer added.

The single-channel Model VM-24,

housed in two portable cases, measures output attenuation, power, frequency and AM and FM characteristics over 10 MHz to 18 GHz.

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EDN's February 4 issue will feature a Special Report on switching power supplies, plus useful articles on

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Technology News

Fiber-optic flashes: Receiver, fibers, interconnect system, computer link

Tom Ormond, Senior Editor

A single-chip optical receiver could lead to more economical fiber-optic computer-system data-communication links. Developed by researchers at IBM's Thomas J Watson Research Center (Yorktown Heights, NY), it employs current-mode amplification to achieve wide bandwidth (180 MHz) and relatively low fabrication cost.

The current design accommodates 200M-bps data rates, a factor-of-13 improvement over commercially available integrated optical receivers producing logic outputs. And anticipated advances in silicon-chip technology could readily extend this performance to 1000M bps.

Current-mode amplification is well suited to integration because it uses few resistors and places few stringent requirements on the device's integrated components—gain and bandwidth depend little on the components' absolute values. It lends itself to implementation with today's standard logic arrays.

Reduced fiber prices could result from a new manufacturing process developed by researchers at Bell Labs, Murray Hill, NJ. A variation on the modified chemical vapor deposition (MCVD) process, the technique uses a plasma—an energetic mixture containing ionized atomic fragments—to speed up preform production (an early step in fiber fabrication).

Experimental results show glass-deposition rates of 2.5g/min—a factor-of-five speed increase over the standard MCVD process. And the technique exacts no performance tradeoffs: Transmission losses of 3.4 and 1.5 dB/km at 0.85 and 1.2 μ m, respectively, compare favor-

ably with figures for today's MCVD-fabricated fibers.

The process is also efficient. It uses more than 70% of the fabrication method's germanium input (compared with less than 5% in current techniques) and nearly 100% of the silicon. (Germanium is the most expensive ingredient in the fiber-forming process.)

A military-aircraft fiber-optic interconnect system developed at Boeing Aerospace Co (Seattle, WA) is helping to demonstrate fiber optics' suitability for critical-information transmission.

Under Navy contract, a Boeing engineering team has redesigned an E-3A aircraft electrical harness to employ fiber-optics technology. The 32-ft-long hybrid harness consists of four twisted-wire power-carrying pairs and 20 fiber-optic communications-signal cables (including both single and bundled fiber designs).

The engineers have also developed techniques for inspecting the cables, plus fabrication, maintenance and quality-control procedures.

Fiber optics has invaded word processing: A fiber link connects a μ C editing terminal with a printer in Vydec Inc's (Florham Park, NJ) Model 4000 word-processing system. The link, fabricated from DuPont Pifax P-240 cable, provides high immunity to induced environmental noise and enhanced data security because fibers are almost impossible to tap remotely.

Although the plastic-fiber cable is relatively lossy, it readily accommodates 30m terminal-to-printer runs. And the fiber's large 368- μ m core diameter has allowed Vydec to implement the optical link using low-cost emitters and connectors.

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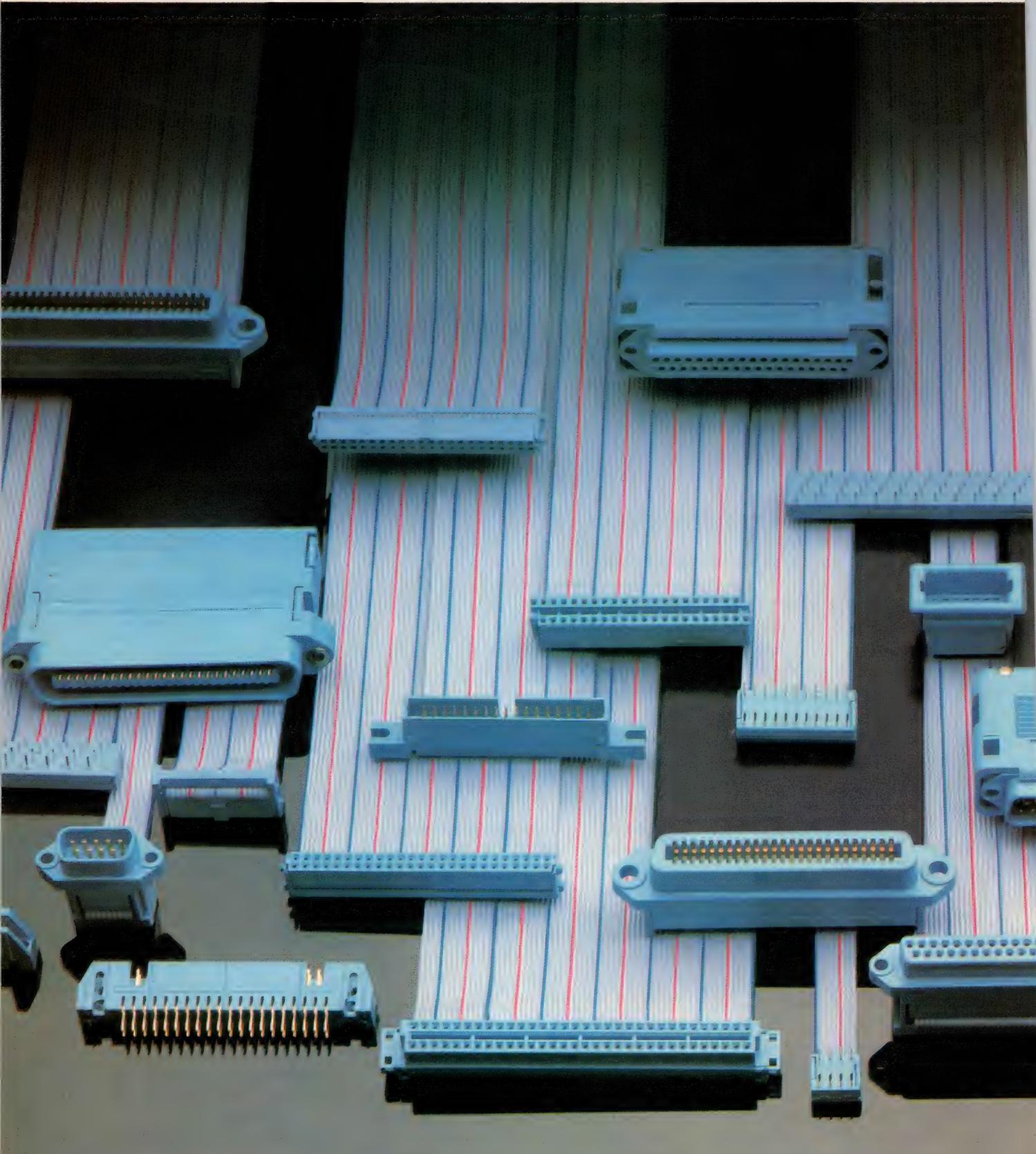
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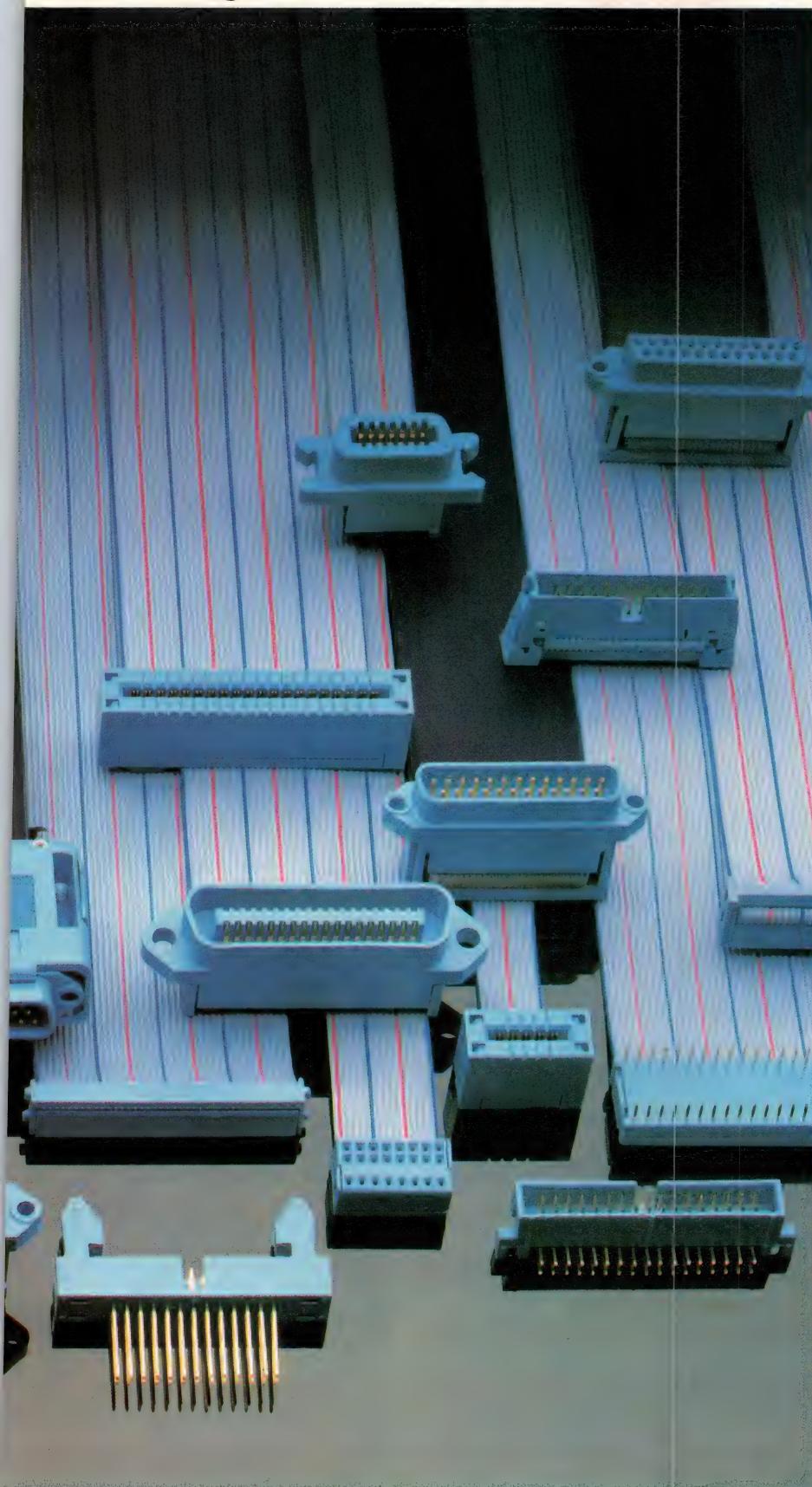
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DEC COMPATIBILITY



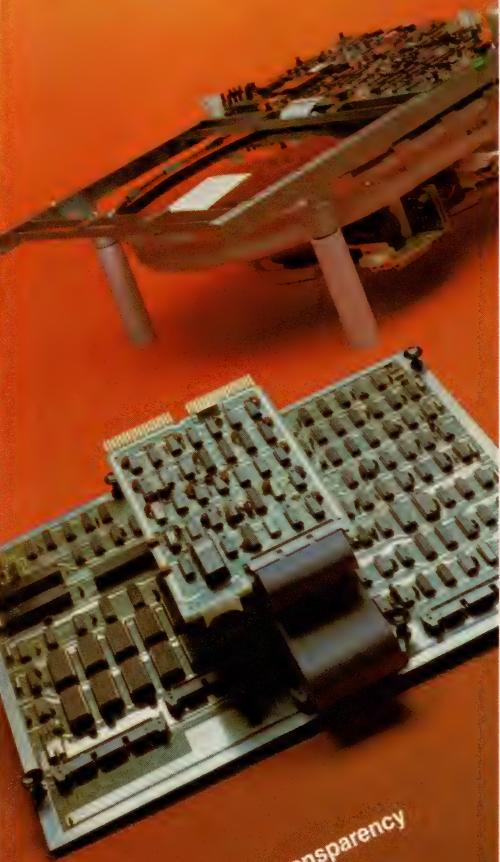
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DEC COMPATIBILITY



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DEC COMPATIBILITY



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Editor's Choice: New Products

Multibus-compatible interface card turns μC into 488-bus controller

Model ZT85/38 GPIB controller card adds IEEE-488 controller, talker and listener capability to Multibus computers. It allows you to transfer data from the host CPU at up to 250k bytes/sec.

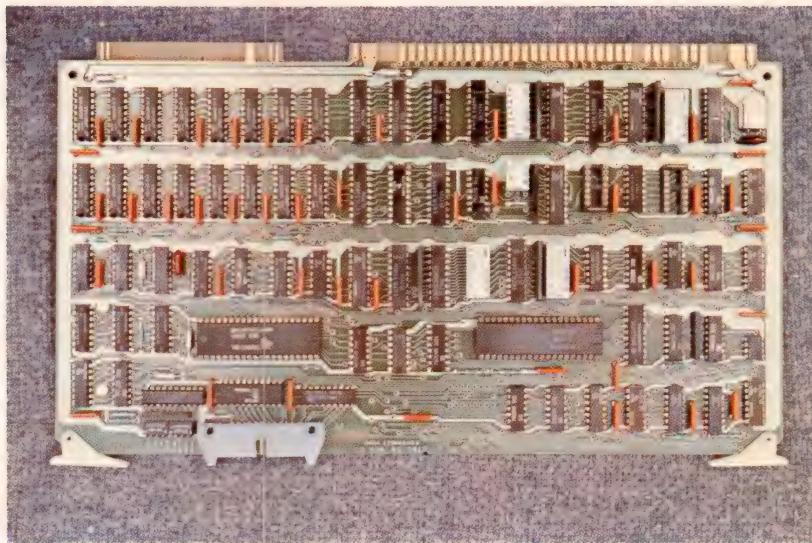
Compatible with SBC 80/XX, SBC 86/XX and MDS 800 microcomputers, the card complies with the IEEE-796 standard for Multibus-compatible systems. It contains 8k bytes of static RAM for buffering or other use; this memory can reside on any 8k-byte boundary within the system's 20-bit-memory-address space and can overlap other system memories using the Multibus INH1 protocol. You can access the RAM as 8-bit bytes or as 16-bit words on even byte boundaries.

Restrict I/O decoders

Input/output facilities include 32 I/O addresses locatable on any 32-port boundary within the card's 16-bit-I/O-address space. You can restrict the unit's I/O decoders to an 8-bit address to provide compatibility with older Multibus-based boards; I/O ports are accessed only as bytes.

Software driver routines (\$125) for DMA and non-DMA operation modes are available on 8-in. single-sided floppy disks. Operating-system formats include CP/M in single-density versions and ISIS in single- or double-density forms.

The card's 16 GPIB interface lines are terminated with Texas Instruments transceiver ICs to provide 400-mV input hysteresis and 0.5V output at 48 mA. Bus



Control 488-bus instruments and peripherals with a Multibus computer and the ZT85/38 interface board, which lets you transfer data at up to 250k bytes/sec.

voltage equals 2.6 to 3.75V with open-collector or 3-state drivers.

Cable option available

The card's standard cable is 2m long and has the GPIB-standard stackable male/female connector at one end. Option 557 (\$50) substitutes a 1m cable with a panel-mount female connector and metric-threaded standoffs.

Data-transfer rates spec at

250k bytes/sec under DMA control, 40k bytes/sec with programmed I/O and 20k bytes/sec (command rate) with the GPIB ATN control line asserted. The card operates from a 5V power supply and draws 2.8A typ, 4.1A max. \$1200.

**Ziatech Corp, 2410 Broad St,
San Luis Obispo, CA 93401.
Phone (805) 541-0488.**

Circle No 450

NEXT TIME

EDN's February 4 issue will feature a Special Report on switching power supplies, plus useful articles on

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- The modeling of memory-system reliability

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299B eliminates destructive media "hubbing," simplifies operation and, allows for complete computer control. And microprocessor controlled self diagnostics make drive maintenance easy.

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Peripherals a Generation Ahead.

Editor's Choice: New Products

18-bit resolution with 16-bit linearity results from MDAC's switching scheme

Achieving high linearities at high resolutions is difficult in any multiplying-DAC design, especially for a 16-bit-linear, 18-bit-resolution device. And the problem doesn't lie in the resistor network, which can be laser trimmed. The CMOS MP370 solves this problem, though, thanks to a novel switching design.

An n-bit DAC generally requires n switches that turn n voltage (or current) sources on or off, depending on which bits are HIGH or LOW. Hence, such a DAC can generate 2^n discrete output levels.

But therein lies the problem: In a 10-bit DAC, for example, a 1% MSB error causes a 0.5% output error; the same 1% shift in the LSB causes only a 0.001% output error. Thus, whatever the intended DAC performance, the MSB causes the accuracy problems.

More switches, less errors

To deal with this difficulty, the MP370 adds switches. For if three lines decode an MDAC's top two MSBs, the maximum single-switch-induced output error drops from 0.5 to 0.25%. Similarly, decoding three MSBs with seven lines reduces switch sensitivity by a factor of four. And serving four MSBs with 15 lines produces a factor-of-eight improvement.

At this point, the law of diminishing returns takes over. And that's where the MP370's manufacturer stopped: The device's top four MSBs are decoded by 15 switches that must be matched to within only



Additional switches combine with extra current sources and resistors to provide the MP370 18-bit CMOS MDAC with true 16-bit linearity. Decoding the unit's four MSBs with 15 switches reduces switch-induced errors by a factor of eight. A companion MDAC, the 16-bit MP9331, also achieves a 16-bit linearity.

5%; 14 switches handle the remaining 14 bits conventionally. The result? 18 bits you can use.

Two chips reside in the MP370's 28-pin hermetically sealed metal DIP. One contains the 29 resistors employed in the 4-MSB decoding scheme and a conventional R/2R ladder for the remaining 14 bits. The other chip, the workhorse, houses all of the switches along with two 8-bit input storage registers and latch-control logic.

Speed remains high

The MDAC requires one 15V nominal supply at 60 mW max. Speed isn't sacrificed to low power consumption or high resolution; the device's small-signal 3-dB bandwidth specs at 1 MHz, and settling time—for a

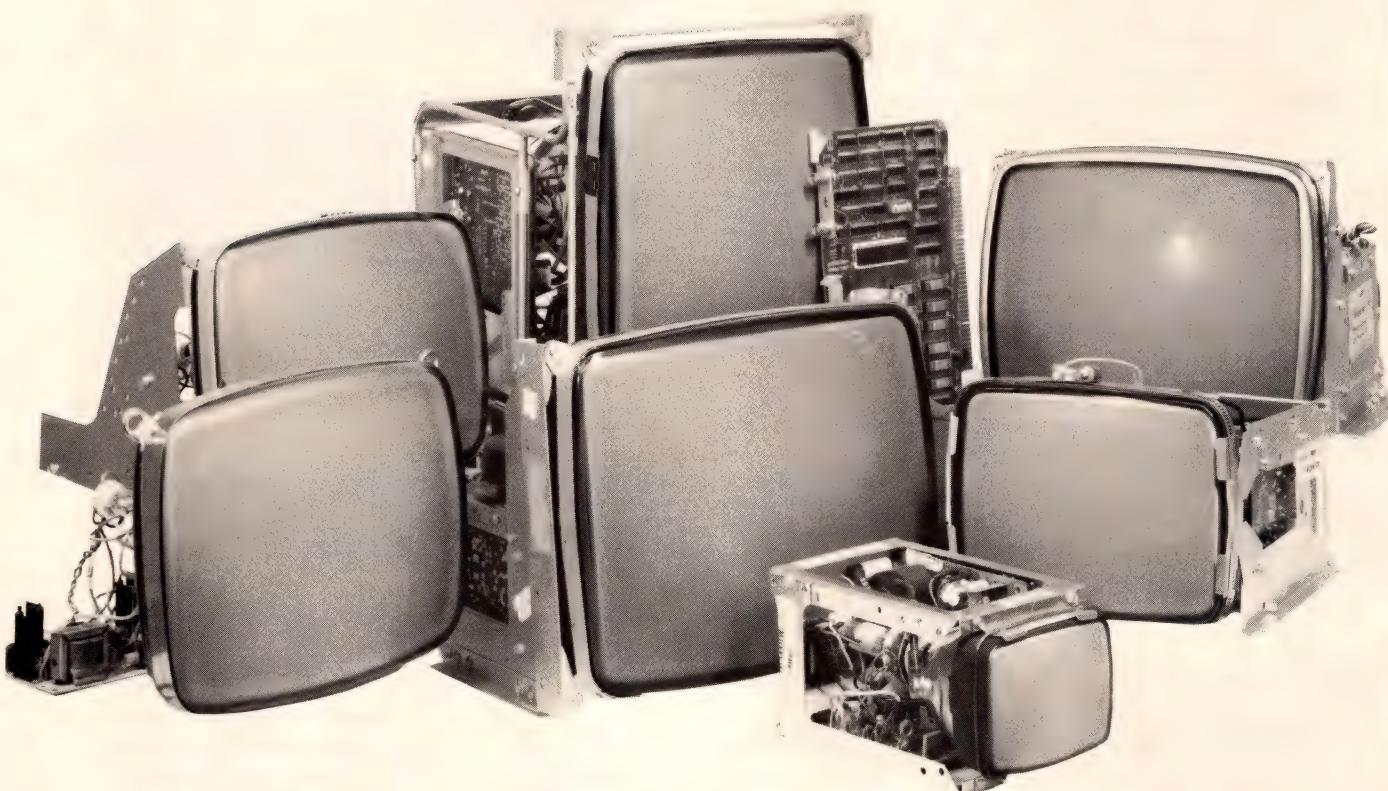
major code transition—is 2 μ sec to 0.01% FSR.

A full 2- and 4-quadrant multiplier, the hybrid specs an input reference-voltage range of ± 25 V. Digital inputs are DTL, TTL and CMOS compatible. The device achieves a noteworthy integral linearity of $\pm 0.0008\%$ (16 bits) and differential linearity of $\pm 0.0004\%$.

Two temperature ranges are available: The -B version operates over -55 to $+125^\circ\text{C}$; the -C unit spans 0 to 85°C . Both types are second sources to Hybrid Systems Corp's DAC370 family. MP370C, \$159; MP370B, \$470 (100).

Micro Power Systems Inc,
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95050. Phone (408) 247-5350.
Circle No 451

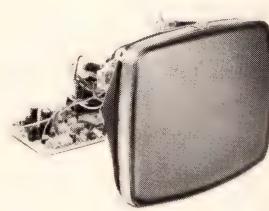
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Editor's Choice: New Products

25W encapsulated switchers compete with 5W linears

Series 325 encapsulated off-line 20-kHz switchers sport three outputs and an \$89 price tag, making them price competitive with 5W 3-output encapsulated linear supplies.

The 14-oz, 2.75×4×1.375-in. supplies come in two versions: Model 325 furnishes 5V at 4A and ±12V at 200 mA, and Model 326 furnishes 5V at 4A and ±15V at 200 mA. Both units operate from 85 to 135 or 170 to 260V (47 to 470 Hz) inputs.

Schottky rectifiers and a half-bridge rectifier provide 80% efficiency independent of load, although the primary output requires a 10%-rated load (min) to ensure regulation. At rated output, surface temperature rises 10°C.

Basic specs include ±0.1% line regulation, ±0.2% load regulation and ±0.02%/°C temperature coefficient. Transient response to within 1% of final output level is less than 300 μsec. Additionally, the switchers provide 1500V ac I/O isolation and 16-msec hold-up time after loss of ac power, and they deliver rated output in -25 to +70°C temperatures.

Oversupply protection and current limiting come standard. Noise and ripple equals 50 mV p-p or 10 mV rms on the primary output; the secondary outputs' series-pass regulators reduce their noise and ripple spec to 5 mV rms.

Encapsulated for performance

Each supply is assembled on one pc board and epoxy encapsulated for resistance to vibration and adverse atmos-



Offering a 25W rating in a 2.75×4×1.375-in. package, Model 325 delivers 5V and ±12V outputs. The off-line switcher operates on 85 to 135 or 170 to 260V ac inputs and features epoxy encapsulation.

pheric conditions. These mechanical features, plus the use of polynylon wire, metal-film resistors and derated electrolytic capacitors, result in an MTBF spec of 45,000 hrs, per MIL-HDBK-217B.

Solder pins and two 4-40 threaded inserts molded into the case facilitate pc-board mounting. The switchers are pin compatible with competing linear supplies but have larger footprints (although they weigh

less).

One feature you won't find on these switchers is extensive shielding and input line filtering. The manufacturer claims that because built-in switcher filters usually don't ensure compliance with FCC and VDE specs, power-supply users generally furnish their own filtering when necessary.

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μ C Design Techniques

EDN Software Note #61

Print decimals without leading zeros

Robert D Grappel

Hemenway Associates Inc, Boston, MA

Printing decimal values with leading zeros can make a printout confusing to read. The code shown in Fig 1 provides a neat and efficient way of eliminating these leading zeros. Although it was written for use in a PASCAL compiler for the Z8002, it works just as well in other environments.

The flowchart shown in Fig 2 illustrates how the program works. The two key points are the division by 10 at OUTD2, which returns both a quotient and a remainder, and the use of the stack to store digits as they are computed.

Beginning at OUTD, the algorithm initializes a digit counter to zero. It then tests the sign of the value under consideration. If the sign is positive, the program jumps to OUTD2; a negative sign causes the routine to output a minus sign and then negate the value.

At OUTD2 the routine divides the value by 10 and converts the remainder, a value between zero and nine, to an ASCII digit. Then it increments the digit counter and pushes the ASCII digit onto the stack.

```
* subroutine to print signed 32-bit values in decimal
* with leading-zero suppression
* coded for the Z8002 processor
* assumes: 32-bit signed value in RR10
* subroutine TYWR outputs ASCII char . in RL0
*
*
```

```
OUTD    CLR B RHL      init digit counter
        TEST R10      value positive?
        JR PL,OUTD2   if so, skip
*
        LDB RLO,#'-'  if not, output minus sign
        CALL TYWR
        COM R10
        COM R11
        ADDL RR10,#1  negate RR10
*
OUTD2   EXTSL RR8      sign of RR10 into RR8
        DIVL RQ8,#10   divide value by 10
        LD R2,R9      get remainder into R2
        ADDB RL2,#'0'  make RL2 into ASCII digit
        INC B RHL     bump digit counter
        PUSH @R15,R2   stack digit
        TESTL RR10    quotient=0?
        JR NZ,OUTD2   if not, loop
*
OUTD3   POF R0,@R15    unstack a digit
        CALL TYWR     output the digit
        DBJNZ RH1,OUTD3 loop through digits
*
        RET          done
```

Fig 1—Suppress leading zeros with this simple Z8002 assembly-language routine.

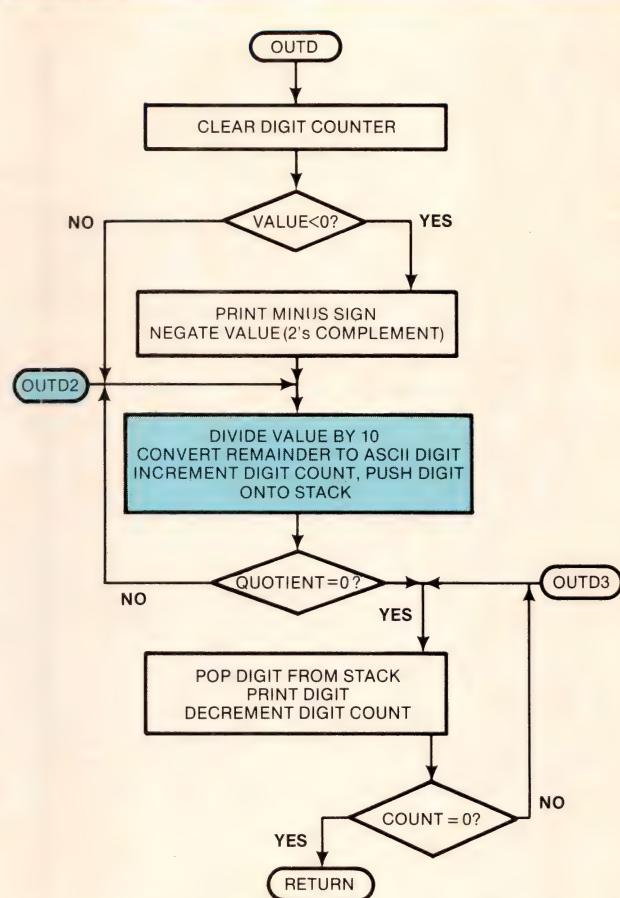


Fig 2—Dividing by 10 at OUTD2 returns both a quotient and a remainder.

If the quotient is zero at this point, the routine goes to OUTD3 to output the stacked digits. If the quotient isn't zero, though, the routine loops to OUTD2 for the next digit.

The output routine at OUTD3 uses the digit counter to keep track of the number of digits that it must print. After producing a digit, it decrements the counter; when the counter equals zero, no digits remain to be printed.

Fig 1's routine accepts a 32-bit value passed in the R₁₀ register pair. It assumes the existence of a routine (TYWR) that outputs an ASCII character stored in register RL₀. Note that the division step uses a quad register (R₈, R₉, R₁₀, R₁₁) as one operand.

μ P evaluation kit forms half-duplex interface

Brett Roberts

Fairchild Camera & Instrument Corp, Syosset, NY

The Motorola 6800 μ P evaluation kit can serve as a half-duplex interface to a teletypewriter when provided with a minimum amount of added hardware.

You need only furnish three power supplies, three ICs, two switches, a fuse, a power-on indicator, a metal box, four tip jacks, one connector, seven resistors and two capacitors.

The interface (Fig 1) provides no extra features. However, you could easily add a 7-segment display for operator messages or even upgrade the circuit

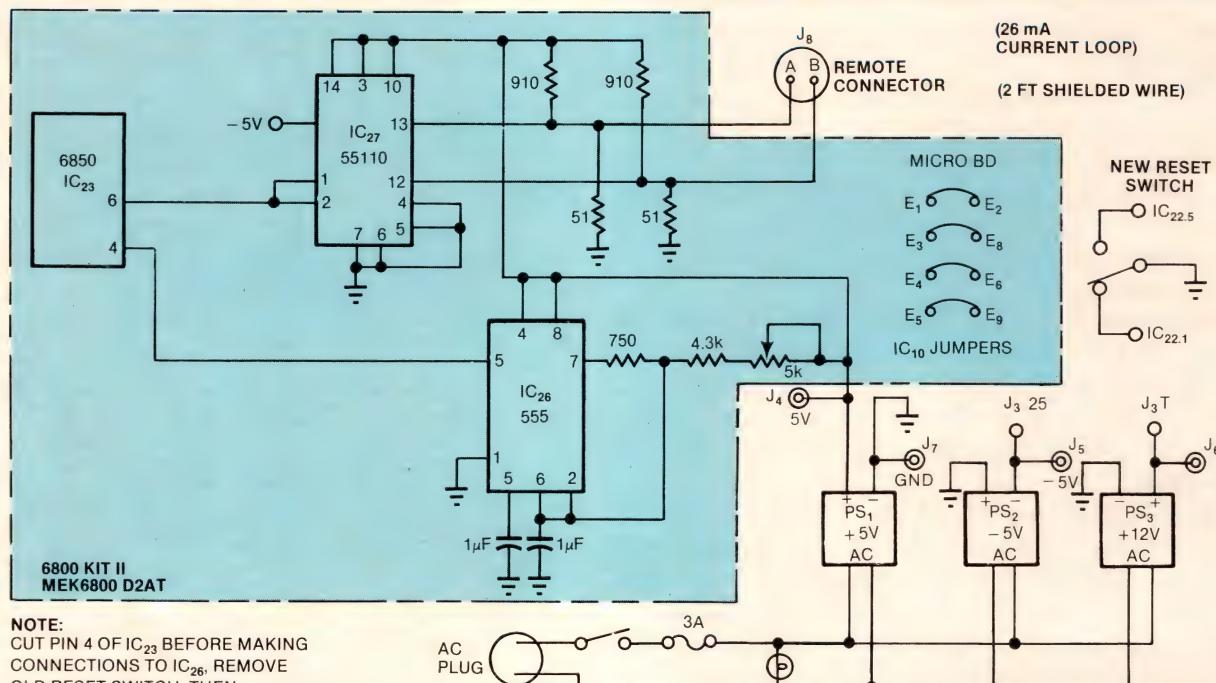


Fig 1—An evaluation board forms the basis for a complete μ P-to-TTY half-duplex interface.

```

*****SUBROUTINE TO DISABLE NMI INTERRUPTS*****
*See NOTE 1
00 86 3C  DISNMI LDA A *$30
02 B7 8021 STA A DISCTR INTR MASKED CA1 ACTIVE LOW
05 B7 8023 STA A SCNCTR INTR MASKED CB1 ACTIVE LOW
08 39 RTS

*****RESTART ROUTINE***** TO RUN PROGRAM TYPE 0009G
09 8E A078 RESTAR LDS *$A078
0C BF A008 STS SP INITIALIZE STACK POINTER
0F CE C080 LDX *$KEYDC GO DECODE KEYBOARD
12 FF A006 STX NIO INITIALIZE NMI INTERRUPT
15 86 FF LDA A *$FF
17 B7 8022 STA A SCNREG *B0-PB7 OUTPUTS
1A 44 LSR A
1B B7 8020 STA A DISREG *A0-PA6 OUTPUTS, PA7 INPUT
1E 8D E0 BSR DISNMI DISABLE KEYBOARD/TRACE

*****INITIALIZE ACIA*****
20 86 03 LDA A *3
22 B7 8008 STA A ACIAS RESET THE ACIA
25 7F A01D CLR VFLAG INITIALIZE VFLAG

*****SUBROUTINE TO CLEAR DISPLAY BUFFER AND FLAGS*****
28 8D 04 INIT BSR CLFLG CLEAR DISPLAY AND FLAGS
2A 01 01 NO OPS
2C 20 52 BRA KEY DC

*****SUBROUTINE TO CLEAR DISPLAY BUFFER AND FLAGS*****
2E CE A014 CLFG LDX *DIGIN4
31 CE A014 CLR A *DIGIN4
32 A7 00 CLFLGL STA A 0,X CLEAR DIGIN4 AND DIGIN5
34 08 INX CLEAR MELAG AND RFLAG
35 8C A01A CPX *DIGIN4+6 END?
38 26 F8 BNE CLFG1 NO LOOP BACK
3A CE A00C LDX *DISBUF CLEAR NFLAG AND TEMP2
3D FF A01A STX XKEYBF INITIALIZE XKEYBF
40 86 7F CLRDS LDA A *$7F
42 B7 8020 STA A DISREG BLANK DISPLAY
45 86 11 LDA A *17
47 CE A00C LDX *DISBUF
4A A7 00 CLRDS1 STA A 0,X CLEAR OUT DISPLAY BUFFER
4C 08 INX
4D BC A014 CPX *DISBUF+8 END?

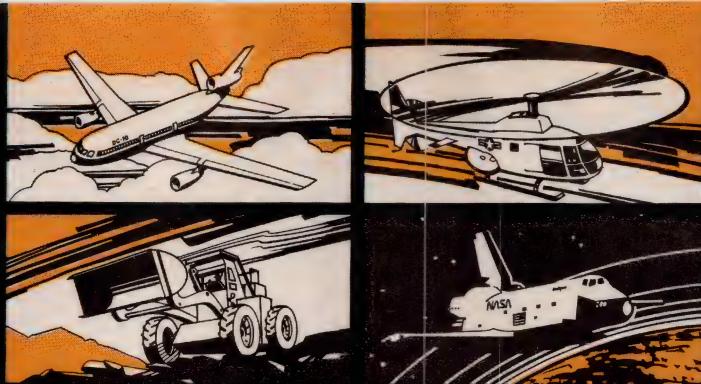
*NOTE 1: ALL ADDRESSES PREFIXED BY C0.

50 26 F8 BNE CLRDS1
52 39 RTS
53-58 01 NOP

*****SUBROUTINE TO DELAY 20 MS DR X MS *****
WHEN ENTERING AT DLY1 THE XREG MUST CONTAIN
THE DESIRED DELAY CT (APX 13USEC/COUNT)
59 CE 0600 DLY20 LDX *$0600

```

Fig 2—A 273-byte program performs all the necessary interfacing tasks and leaves plenty of ROM space for your own routines. (Listing continues on pg 80.)



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μC Design Techniques

```

5C 09 DLY1    DEX
5D 26 FD      BNE DLY1
5F 39 RTS
    ***SUBROUTINE TO SCAN KEYBOARD*** 
60 86 FF KEYCL  LDA A *$FF
62 CE 8020      LDX *DISREG
65 A7 00 STA A 0,X   BLANK DISPLAY
67 86 3F LDA A *$3F
69 A7 02 STA A 2,X   ALL ROWS LOW
6B A6 02 KEYCL1 LDA A 2,X
6D 6D 00 TST 0,X
6F 2A 08 BPL KEYCL2 KEY DOWN?
71 8B 40 ADD A *$4
73 A7 02 STA A 2,X   SELECT NEXT COLUMN
75 84 C0 AND A *$C0
77 26 F2 BNE KEYCL1 LAST COLUMN SCANNED?
79 39 KEYCL2  RTS NO KEY BOUND
7A-7F 01 NOP
    ***ROUTINE TO SCAN AND DECODE KEYBOARD*** 
80 8D DE KEYDC  BSR KEYCL
82 27 FC BEQ KEYDC NO KEY CLOSED
84 8D D3 BSR DYL20
86 CE 8020      LDX *DISREG RESTORE X
89 86 01 LDA A *$01 SETUP SCAN FOR FIRST ROW
8B A7 02 STA A 2,X
8D 8D DC KEYDC1 BSR KEYCL1 SCAN KEYBOARD, GET KEY
8F 26 0A BNE KEYDC2 KEY FOUND
91 A6 02 LDA A 2,X   CLEARS NMI INTERRUPT
93 81 20 CMP A *$20
95 27 E9 BEQ KEYDC LAST ROW
97 68 02 ASL 2,X   SHIFT LEFT
99 20 F2 BRA KEYDC1
9B 5F KEYDC2 CLR B   INITIALIZE COUNTER
9C CE E3D3      LDX *KEYTBL
9F A1 00 KEYDC3 CMP A 0,X   SEARCH TABLE
A1 27 09 BEQ KEYDC4
A3 8C E3F4      CPX *KEYTBL+24 END OF TABLE?
A6 27 61 BEQ KEYDOF NO KEY FOUND IN TABLE
A8 98 INX
A9 5C INC B   ADVANCE
AA 20 FE KEYDC4 BRA KEYDC3
AC 8D KEYDC4 BRS KEYCL
AD B2 BNE KEYDC4 WAIT FOR KEY RELEASE
AE 26 JSR DYL20
B0 BD
B1 C0
B2 59
B3 01 NOP
B4 01 NOP
B5 01 NOP
B6 01 NOP
B7 01 NOP
B8 CE LDX
B9 C0 WITH
BA C2 1 ADDRESS LESS THAN STARTING DATA ADDRESS
BB 5C INC B
DC 08 INX
BD 5A DEC B
BE 26 BNE
BF FC TO BB
C0 7E JMP
C1 C0 TO
C2 E0 ASCII
    ASCII KEY
C3 2E .
C4 21 1
C5 22 2
C6 23 3
C7 24 4
C8 25 5
C9 26 6
CA 27 7
CB 28 8
CC 29 9
CD 41 A
CE 42 B
CF 43 C
DO 4B K
D1 48 H
D2 53 S
D3 50 P
D4 54 T
D5 58 X
D6 59 Y
D7 51 Q
D8 0D CR
D9 52 R
DA 47 G
DB 01
DC 01
DD 01
DE 01
DF 01
EO A6 LDA
E1 00
E1 B7 STA
E3 00
E4 DF
E5 01 NOP
E6 86 LDAA
E7 09
EA 08
EB CE LDX
EC 00
ED 08
    EE B6 LDA
    EF 00
    FO DF
    F1 BD BSR
    F2 E3
    F3 7A
    F4 09 DEX
    F5 26 BNE
    F6 27 LOOP TO EE
    F7 7E JUMP TO RESTAR
    F8 C1
    F9 03
    ***SUBROUTINE TO DISABLE NMI INTERRUPT*** 
    FA 86 3C DISNMI LDA A *$3C
    FC B7 8021 STA A DISCTR INTR MASKED CA1 ACTIVE LOW
    FF B7 8023 STA A SCNCTR INTR MASKED CB1 ACTIVE LOW
    102 39 RTS
    ***RESTART ROUTINE*** 
    103 8E A078 RESTART LDS *#A078
    106 BF A008 STS SP INITIALIZE STACK POINTER
    109 CE 0080 LDX *KEYDC GO DECODE KEYBOARD
    106 FF A006 STX NIO INITIALIZE NMI INTERRUPT
    *INITIALIZE KEYBOARD/DISPLAY PIA
    10F 86 FF LDA A *$FF
    111 B7 3022 STA A SCNREG PBO-PB7 OUTPUTS
    114 44 LSR A
    115 B7 8020 STA A DISREG PAO-PB6 OUTPUTS, PA7 INPUT
    118 8D E0 BSR DISNMI DISABLE KEYBOARD/TRACE
    **INITIALIZE ACIA**
    11A 86 03 LDA A *3
    116 B7 8008 STA A ACIAS RESET THE ACIA
    11F 7E C080 JMP KEYDC

```

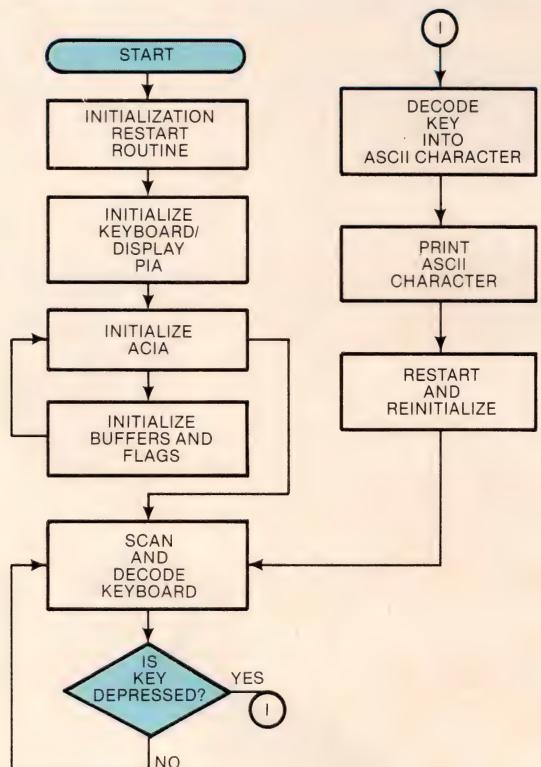


Fig 3—Follow this flowchart to write similar programs for other μP evaluation boards.

for full-duplex operation.

The design's software program (**Fig 2**) requires only 273 bytes of the 2k ROM space available on the μP board; you can enter this code directly. The software's flowchart (**Fig 3**) illustrates the few operations the code must perform to provide half-duplex operation.

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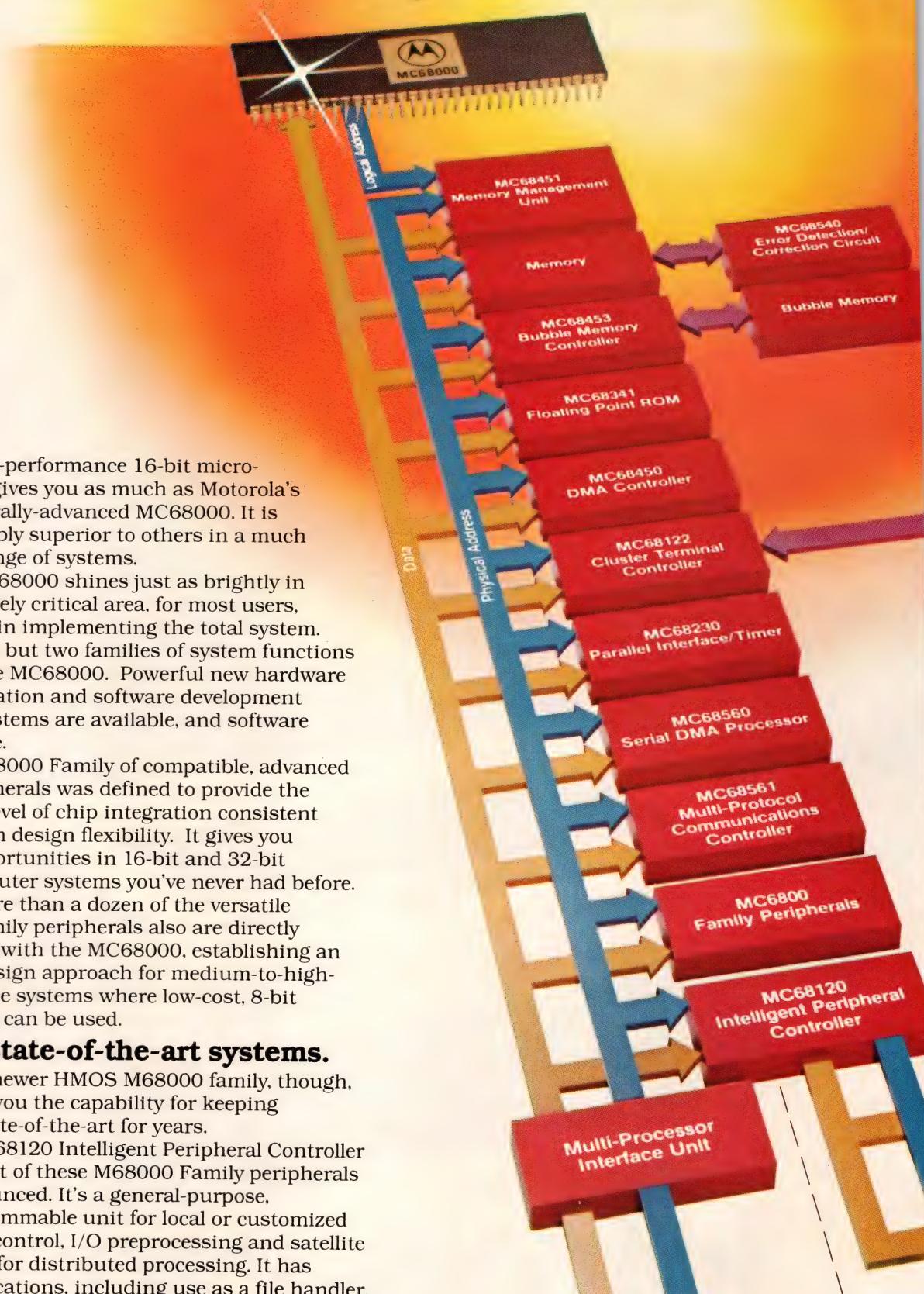
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Also scheduled for imminent introduction are a Cluster Terminal Controller, the MC68122, and a compatible bipolar interface Error Detection and Correction circuit, the MC68540 (also numbered MC34040). The Cluster Terminal Controller will relieve the host processor of the coordinating task for communications between and among terminals, and the EDAC circuit performs the error check/correct function in 8-bit or 16-bit systems. It's directly expandable to 32-bit operation.

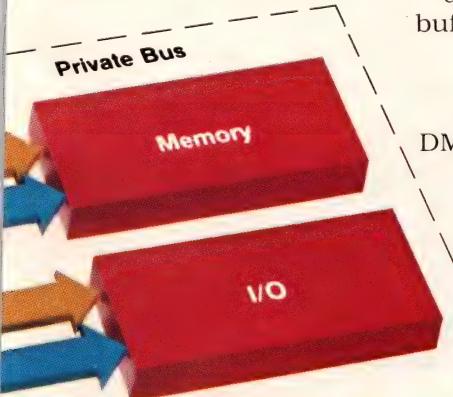
More HMOS VLSI.

Following these,

availability is scheduled for the MC68451 Memory Management Unit, MC68450 DMA Controller, MC68230 Parallel Interface/Timer and the MC68341 Floating-Point ROM.

The MMU provides address translation and protection of the 16-megabyte MC68000 addressing space and can be accessed by any potential bus master. The DMAC offers the optimum in data transfer, and internal 32-bit registers ensure upward software compatibility with future M68000 Family processors. Still other M68000 Family peripherals now planned include a Multiprotocol Communications Controller, a Dual-Port RAM for multiprocessing systems or applications like CRT refresh and

disk interface buffer, a Bubble Memory Controller and a serial DMA Processor.



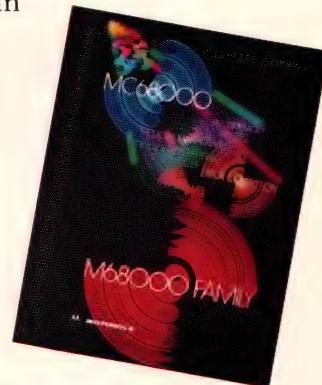
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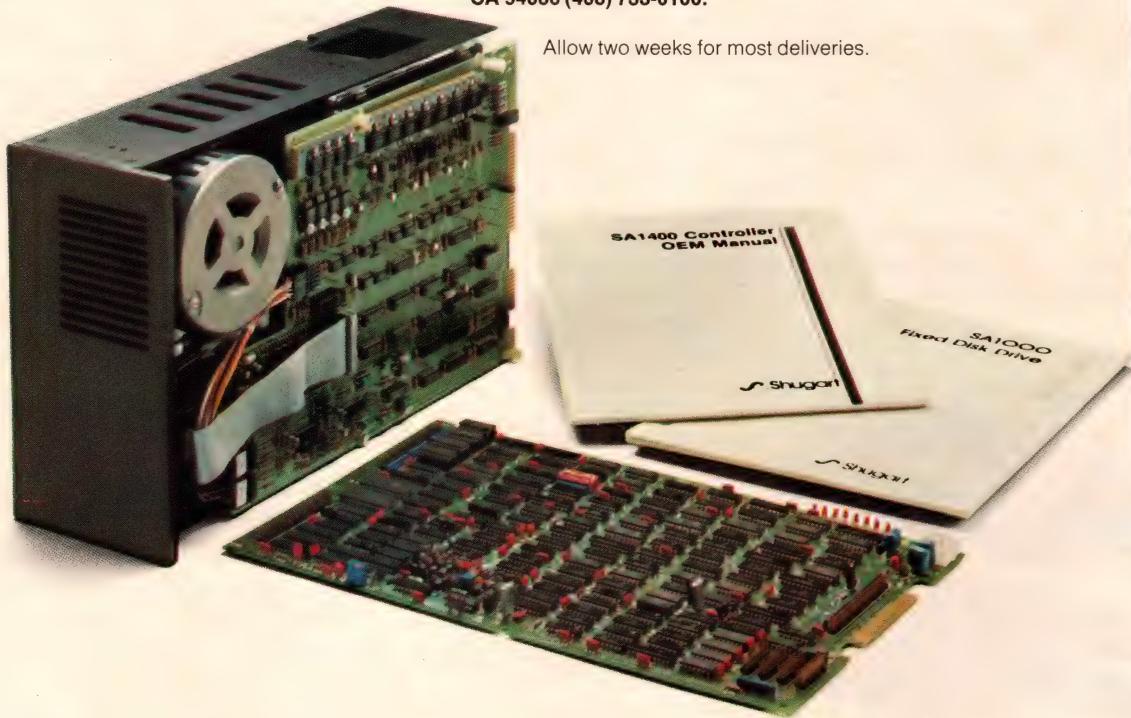
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A Question of Law

When a judgment of patent invalidity short circuits a patent-infringement suit

Professor H Newcomb Morse
Pepperdine University, Malibu, CA

Can a holder of a patent recover damages for infringement if his patent is subsequently ruled invalid?

The Sensytrol Corp brought suit in the US District Court for the Southern District of New York against the Radio Corp of America (RCA), charging it with patent infringement by its manufacture, use and sale of Type CR-101-A radar equipment. The patent in question, designated 2,238,040 (the '040 patent), was originally issued to Harry Dickens but subsequently assigned by him to Sensytrol.

Neither a tinkerer nor an inventor be

Dickens was a US citizen who had been brought up in Germany before World War I and had received the equivalent of a trade-school education at a technical institute. Although never engaged professionally in the electronics industry, he retained an interest in electronics from his school days and was aptly described by his attorney during the trial of the suit as a tinkerer. When his patent was issued, he was employed by a radio station in Washington, DC, as a program director.

Dickens's invention evolved from a discussion with friends about the high incidence of automobile accidents. In the course of the discussion, he had proposed a device, mounted on an automobile, that would generate an electromagnetic wave. Reflected from another object, the wave could activate a car's brakes under certain conditions and thereby prevent collisions. A model of such a machine was constructed, and on February 25, 1936, Dickens applied for a patent.

A long and tortuous course

The patent application followed a long and tortuous course through the Patent Office, encountering four rejections and accumulating seven amendments. Its difficulties were probably the result of Dickens's deficient technical education, which left him unaware of developments in the rapidly changing field of radar and its associated electronics.

Dickens admitted at the trial of Sensytrol's suit that neither his device nor the circuit he had patented had found commercial use. Additionally, none of these devices had been manufactured or sold, and no licenses had been granted. Furthermore, his expert witness testified at the trial that he had never seen the machine operate.

During the trial, an instrument built according to the '040 patent's specifications was brought into court but failed to work. Thus, while a lack of commercial utility is not necessarily a conclusive factor in a patent case, it is, nevertheless, a factor that can be taken into account in determining a patent's validity.

Patent Office examiner rejects 33 claims

On October 23, 1939, a Patent Office examiner had rejected all 33 claims in Dickens's original patent application on the grounds of prior disclosures of the art involved. On May 30, 1940, Dickens had withdrawn these claims and proposed Claim 34, which was subsequently allowed by the Patent Office. In a letter preceding this amendment, Dickens's attorney had stated: "Applicant has restricted [patent] protection to the specific disclosure of the[se] circuits..."

Claim 34 described Dickens's device in the following terms:

"A control for power circuits, comprising two substantially identical thermionic oscillators connected in parallel to each other, each oscillator including a grid circuit having a coil and a tuning condenser, [and] to a source of plate-current supply. A relay [is] interposed in the plate circuit between...[the] source of supply and...[the] oscillators, the grid circuit of one of...[the] oscillators directing its radiant energy in a beam...[The] oscillators normally maintain...[the] relay in one position during unobstructed flow of radiant energy from the grid circuit. [The] obstruction of...[the] radiant-energy flow reacting on the system...shift[s] the energy distribution between the oscillators and thereby cause[s] a plate-current change in each oscillator...[This] change in plate current to the two oscillators causes operation of the relay to a different position."

In summarizing the '040 patent in its brief, Sensytrol explained it as follows:

"The '040 patent here involved relates to an

A Question of Law

electrical circuit utilizing radio waves for object-detection purposes. The circuit disclosed by the patent...employs two oscillators A and B comprising appropriate tank circuits...coupled to a single antenna and to a relay. Oscillator A generates a radio-frequency signal that is sent out through the antenna for a short interval depending on the values selected for the grid-leak circuit.

"As was pointed out at trial and is well known in the prior art...the grid-leak components...served to provide for periodic interruptions (or pulsing) of the oscillations of these oscillators.

"During the period of quiescence, the radio wave transmitted via the antenna and produced by oscillator A will, upon striking an object, be reflected therefrom to the antenna...whence the reflected signal induces a radio frequency in the antenna that is passed to a common conductor...joining oscillators A and B.

"Oscillators A and B are set up to beat against each other, so that while one oscillator is quiescent, the other is active and vice versa. During the period of quiescence of oscillator A, any signal reflected back to the antenna...will be mixed with the signal generated by oscillator B.

"Since there is a relative movement between the transmitting apparatus and any object detected, there will be a variation of this reflected frequency from the initially transmitted frequency due to the Doppler effect. The slight difference in frequency produced by the Doppler effect on the reflected signals will reflect in a beat frequency in [the common conductor]...as a result of the slight difference between the frequency of oscillator B and the Doppler-effected reflected signal. This beat frequency serves as an IF or intermediate frequency for actuation of the relay..."

Anticipation the mother of invention?

The problem thus facing the District Court was whether the prior art anticipated the particular circuits described in Claim 34 (the only claim allowed in Dickens's patent).

In this respect, the use of electromagnetic or radio waves transmitted through the air for the detection of objects was known before Dickens's invention, and the principle was employed in patents awarded to Edwards (1934), Ballantine (1935) and Patterson (1935), among others.

The Edwards patents, for example, use a self-pulsing triode oscillator and an oscillating circuit operating 180° out of phase as well as a relay that is activated by imbalance in the system. The Ballantine patent also utilizes these elements, as well as a directional antenna. Furthermore, Dickens's method

of activating the relay had earlier been employed in patents issued to Walter Schaffer (1929) and Edward B Mallory (1932).

The Patent Office examiners had considered the Mallory patent in detail—an evaluation that had led them to reject and cancel 20 of Dickens's original patent claims. The Mallory patent describes a burglar alarm containing two triode thermionic oscillators. The first of these has a fixed frequency. The other connects to an antenna so that an object coming within its range varies the oscillator's frequency. Utilizing the superheterodyne principle, the circuit creates an intermediate frequency that, when rectified, operates a loudspeaker or other indicating device.

The Mallory device employed two triode thermionic tubes and two oscillatory circuits, both of the Dickens type, and a single antenna. Oscillator B, as in Dickens's specification, operated at a constant frequency.

The following extract from the Mallory patent specifications constitutes a reasonably fair statement of Dickens's activation principle:

"The frequencies of these two thermionic tube oscillators are so chosen that the frequency of the beat note produced by their interaction in the sound producer...is either zero or at a frequency above or below audibility. If, however, the capacitance between the element 10 and the ground 23 is changed by change in the dielectric between these elements, the frequency of oscillation of tube 1 will be altered, and the constants of the circuit are so chosen that any change in this frequency will give rise to an audible beat note...When...the dielectric constant of the protected space is changed by the ingress or presence of a foreign agency or object, the frequency of oscillation of tube 1 is changed sufficiently to give an audible signal."

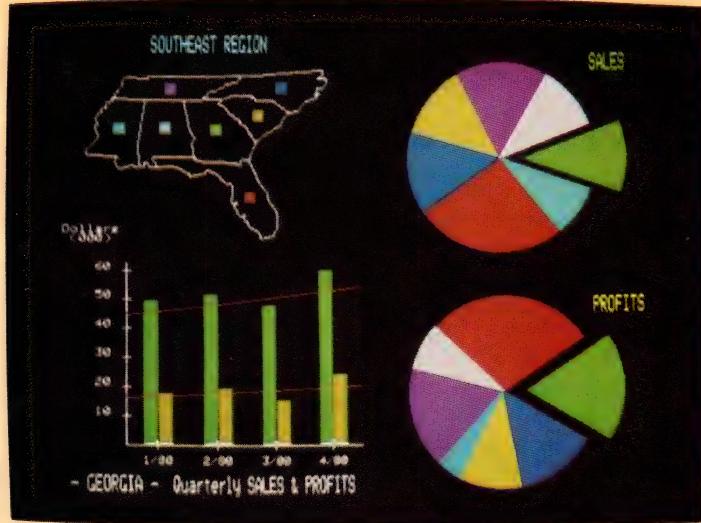
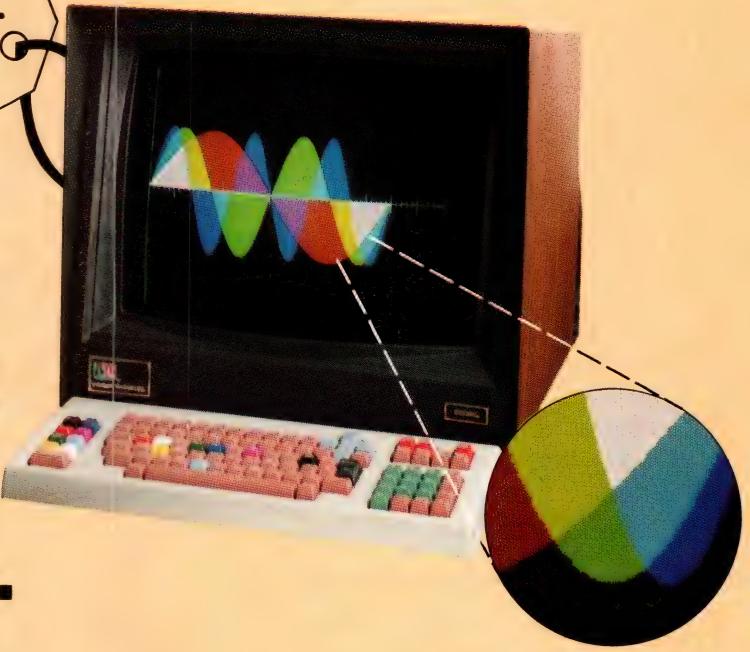
Dickens had finally differentiated his device from Mallory's by confining himself to two oscillators with identical frequencies and by pointing out that the Mallory machine had to be grounded to work, whereas his invention did not necessarily have to be grounded.

Patterson patent anticipates Dickens's device

The type of circuit described by Dickens was also anticipated in the Patterson patent. Issued on November 26, 1935, it details an airborne radio-echo altimeter that determines an aircraft's altitude. Because the circuits involved were substantially the same as those described by Dickens, the Patent Office had cited the Patterson patent against him. Dickens's attorney, however, had distinguished between the two patents:

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A Question of Law

"Wholly aside from the fact that Patterson may, in a manner, accomplish a similar result, the patent does not meet the specific claims now pending, for as the [Patent Office] examiner admits, in an official letter, Patterson has but one oscillator. The applicant [Dickens] has restricted the desired protection to the specific disclosure of the circuits and their details..."

Thus, the Patterson device accomplished the same result as Dickens's but was distinguishable from it on the ground that it employed one oscillator, while Dickens's unit employed two.

The Schaffer patent, which preceded Dickens's patent application by almost 10 yrs, had not been cited by the Patent Office. But it showed a circuit almost identical to Dickens's, employing two coupled thermionic oscillators of constant identical frequency. Schaffer's specifications even describe the relationship of the two oscillators along the lines of Dickens's description.

District Court declares patent invalid

In 1961, the US District Court took note of these facts and dismissed Sensytrol's lawsuit, declaring:

"...we have a situation here where the type of circuit involved was anticipated by the Patterson patent, but the [Patent Office] examiner apparently found a distinction in Dickens's use of two oscillators. However, this feature was clearly anticipated by Schaffer, a fact of which the examiner apparently was not aware. Thus, there was in the application of Dickens no novelty, and no presumption of validity can arise from the patent grant if the Patent Office did not consider the Schaffer patent, which apparently it did not...Since the [Dickens] patent is invalid, it becomes unnecessary to consider whether the radar apparatus manufactured by the defendant [RCA] infringes the patent."

EDN

H Newcomb Morse, JD, LL M, FAAFS, received the Juris Doctor degree from Tulane University and the Master of Laws degree from the University of Wisconsin. He is currently Professor of Law at Pepperdine University.

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PE-14T	Yes	6	108.50
PE-24T	Yes	9	154.50
PL-265T	Yes	20	225.00
PR-125T	Yes	16	339.00
PR-320T	Yes	36	549.00
PC-1000	Yes	72	1,050.00
PC-1100	Yes	72	1,050.00
PC-2000	Yes	144	1,795.00
PC-2200	Yes	144	1,795.00
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*Circle no 45 for general information
Circle no 46 for detailed specifications*

Burroughs

Serial Impact Printers

Dot-matrix units are rapidly invading the realm of fully-formed-character devices, forcing OEM designers to take a second look at their applications' requirements.

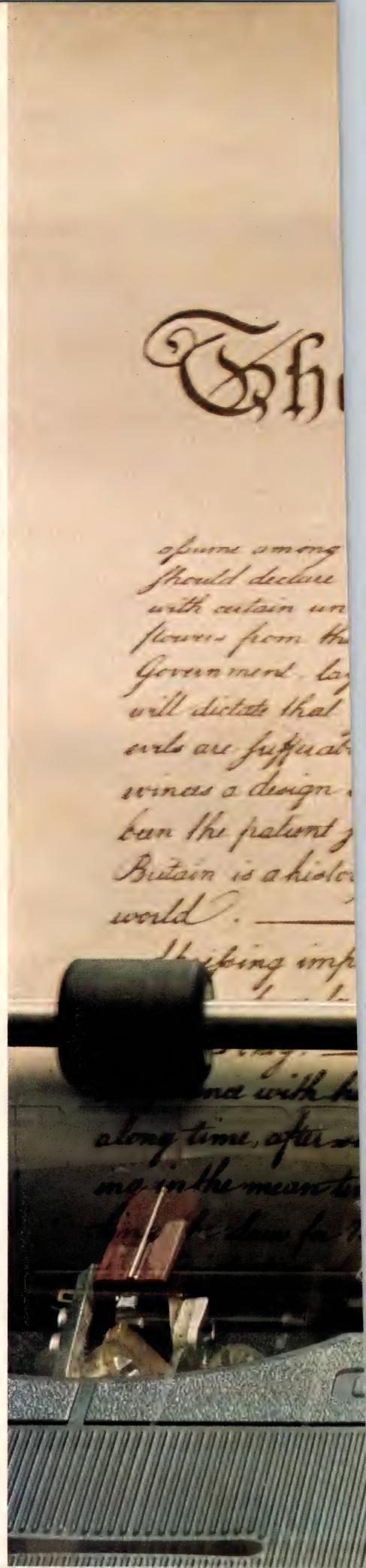
Carl Warren, Western Editor

The growing demand for hard-copy printouts in data- and word-processing applications is making serial impact printers increasingly important components of OEM systems. And to satisfy this increased demand, printer manufacturers are offering a growing range of products with extensive new capabilities.

Faced with the expanding list of choices, you might have difficulty making a wise and cost-effective selection. And recent advances in dot-matrix print quality could further complicate the selection process; these advances are spurring OEMs' interest in dot-matrix printers as viable, cost-effective alternatives to fully-formed-character units for a broad range of applications. Meanwhile, manufacturers of fully-formed-character printers aren't sticking their heads in the sand; they, too, are responding to OEM needs with lower cost designs that compete with the less-than-\$1000 dot-matrix units. And they're offering more functions on current models without appreciably raising those printers' prices.

How can you find your way through this morass of sometimes conflicting considerations? Start by asking several questions whose

Declare your independence from poor-quality printouts with the latest serial impact printers. (Photo courtesy Qume Inc)



IN CONGRES

ranimous Declaration of the Thirteen

When in the course of human events, it becomes necessary for one
of the earth, the separate and equal station to which the Laws of Nature and of Nature's
which impel them to the separation . WE hold these truths
Rights, that among these are Life, Liberty and the pursuit of Happiness —
of the governed; — That whenever any Form of Government becomes destructive of
Foundation on such principles and organizing its powers in such form, as to th
ents long established should not be changed for light and transient causes; and
to right themselves by abolishing the forms to which they are accustomed. Be
them under absolute Despotism; it is their right, it is their duty, to throw off su
of these colonies; and such is now the necessity which constrains them to alter
ated injuries and usurpations, all having in direct object the establishment of a
He has refused his Agents to Laws, the most wholesome and necessary for the
unlawfully suspended in their operation till his Agents should be obtained; and u
— nation at large distinct & independent than that which has
the

Ille has dissolved Representative Houses repeatedly, giving no opportunity
to others to be elected; whereby the Legislative powers, incapable
to all the forms of invasion from without, and convulsions within. —
Ille has obstructed the Laws of Merchants: refusing his Assent to measures
for the reduction of taxes on importation to encourage their migrations hither; and
the

Ask a few key questions to avoid costly mistakes

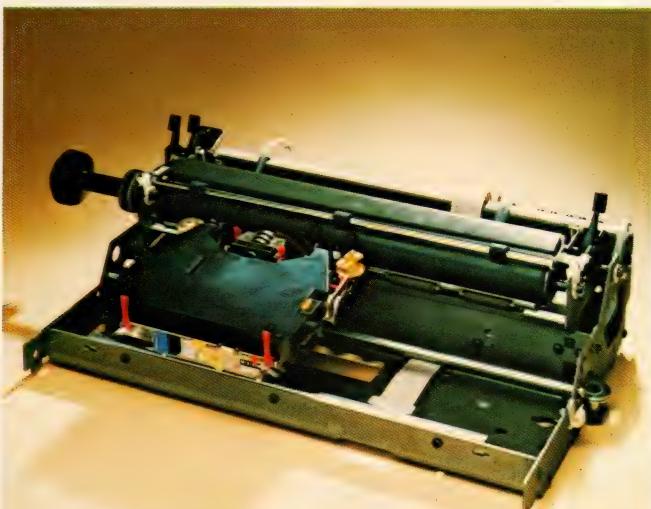
answers help guide the selection process:

- What type of application(s) are you designing for?
- What is your application's required duty cycle?
- Will your system use multipart forms?
- How important is speed to your application?
- What interface meets your system requirements?
- How intelligent must your printer be?
- Do you require special functions (graphics, plotting), or will you in the future?
- What considerations govern your need for spare parts?
- What price are you willing to pay?

This article provides some help in developing and evaluating your answers.



Equipped with dual 8085 μ Ps and a 512-character receive-data buffer and achieving print rates from 30 to 120 cps, General Electric's Terminate 2000 Series printers suit desktop data-communication requirements.



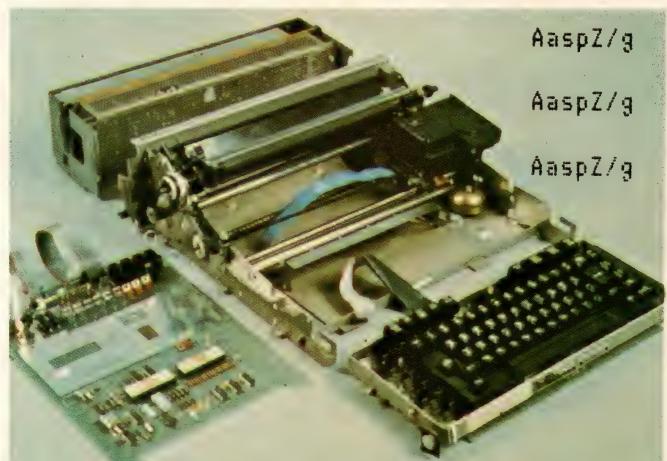
Producing as many as 100 characters in several type sizes, fonts and languages, Pertec's daisy-wheel Stylist 360 operates at a relatively slow 17 cps but costs only \$730 (1000).

The application's most important

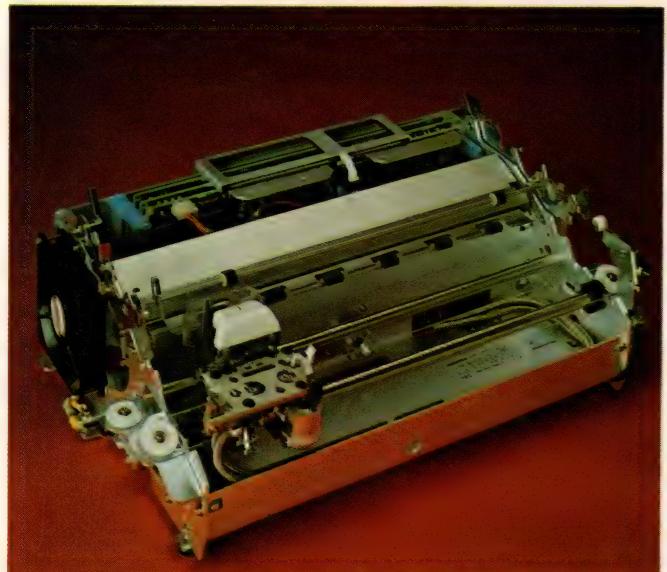
Which printer technology—dot matrix or fully formed character—should you choose? Your application is the primary factor governing the answer to this question. For example, because word-processing applications require "quality" printing, a fully-formed-character printer, such as those manufactured by Qume, Diablo and NEC, would appear to be the natural choice for them.

Unfortunately, "quality" can be subjective. However, system designers agree that the best method of measuring it uses the IBM Selectric typewriter as a standard. This comparison points up the major attributes of quality printing, especially with regard to the output of a 7-wire dot-matrix printer (Fig 1). Note, for example, that the Selectric's print clarity is constant, whereas the dot-matrix output is less smooth.

But even though a fully-formed-character printer provides quality printing, it exhibits some drawbacks,



Shown disassembled, Teletype's Model 43 uses a 9-wire single-column printhead to produce a 7×9 matrix. It concedes speed (achieving 47 cps max) to ensure reliability and print quality (note sample)—both important attributes for unattended data-communication applications.



Employing a thimble-type print mechanism, NEC's Model 5500 Spinwriter comes in the basic form shown here, consisting of the mechanism and internal electronics. It's available with Diablo-, Ontel- or Qume-type interfaces.

particularly with regard to print rate. Most fully-formed-character printers achieve their print clarity—including precise line and character registration—by operating at a relatively low rate: 55 cps is a typical speed. This low rate virtually precludes their use in electronic-data-processing (EDP) applications, where a high print rate is paramount. If you do use a fully-formed-character unit in an EDP application, increased duty cycle (the percentage of time the printer is actually printing) severely inhibits the unit's life.

The bottom line? If your application requires printing speeds in the 120- to 340-cps range, a dot-matrix design will probably prove necessary. And you'll just have to accept the resulting lower print quality: A typical 7-pin dot-matrix head prints in a 7×7 font, producing characters with varying clarity and no descenders.

All isn't lost, though. To improve dot-matrix units' perceived print quality, manufacturers such as Okidata, Centronics and Epson offer printheads with 9×9

character fonts that permit generation of descenders on lower-case letters. And in some cases, $n \times 9$ fonts—like those in Centronics's Models 753 and 737—permit character definition that compares favorably with that of fully-formed-character printers.

Illustrating another attempt to improve dot-matrix printers' perceived print quality, Malibu Electronics's Model 200 (slated for March deliveries) operates in two modes. In high-speed EDP applications, its standard matrix head outputs 165 to 250 cps. And in word-processing applications, a 2-pass printing technique produces a 42- to 60-cps output that the firm claims exhibits letter quality. Resolution of the \$2000 (100) unit's graphics equals 120×144 dots/in.

Several other application-related considerations bear on the choice of a printer technology. For example, John Leighton, Rexon Business Machines manager of product planning, notes that an application geared more toward report generation than word processing lends itself to use of a dot-matrix printer. However, the printer in such an application could be used for a certain amount of word processing, especially on internal documents that don't require letter quality.

Dataproducts vice president Ron Morley agrees. But he also contends that just because quality is quite subjective, dot-matrix-printer manufacturers are aiming to change OEMs' perception of it; those OEMs will then ultimately determine the standards accepted by end users. Morley suggests that the situation in print quality is much like that of photocopies: A few years ago, a photocopy was unacceptable in some applications; now, perceived photocopy quality is good enough to be widely accepted. If Morley is correct—and trends tend to support his view—dot-matrix printers will eventually supplant fully-formed-character units in numerous applications.

Duty cycle proves critical

Another factor to consider when choosing a printer, and one that bears directly on the application, is the printer's required duty cycle. Indeed, John Barny, Microdata's director of terminal engineering, ventures that duty cycle is one of the more critical items affecting selection precisely because it's so misunderstood.

Barny suspects that designers frequently place high-speed dot-matrix printers in the same league as line printers, employing them in applications requiring 8-hour-a-day, 5-day-a-week operation. The result, just as in the case of fully-formed-character units used in EDP applications, is a high failure rate. Typically, serial dot-matrix printers have rated duty cycles of only 25%.

How do printers subjected to abnormally high duty cycles fail? Primarily in the printhead. Daisy wheels or thimble mechanisms, for example, exhibit unusually high print-face wear and a tendency to break. Dot-matrix heads, on the other hand, tend to heat up. As a result, their wires misfire and produce incomplete characters.

To increase their printers' permissible duty cycle,

AaspZ/g

AaspZ/g

Fig 1—Although this example grossly overstates the differences between fully-formed-character and dot-matrix printers, it does point up the nature of perceived print quality. The top row is from an IBM Selectric II electric typewriter; the bottom row, from a 7-wire single-column-head dot-matrix printer. Character height for both fonts is 0.1 in., and both outputs are enlarged 300%. You can see that the fully formed characters are extremely clean and sharp, whereas the dot-matrix characters are jagged. Notice also that the dots separate and tend to bleed—a function of ink density and paper consistency.

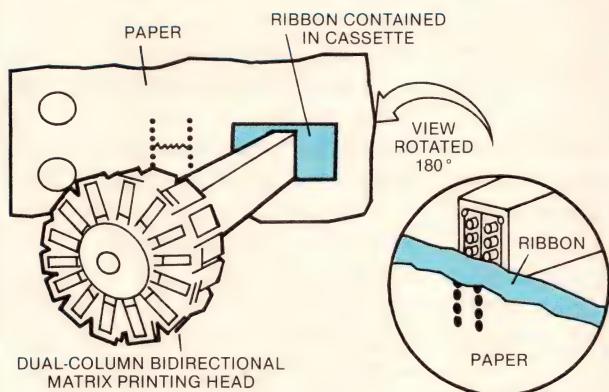


Fig 2—One method that increases permissible head duty cycle involves the use of multiple wire columns. Dual 7-wire columns create a character in alternating steps; the right column—viewed facing the paper—fires first, and as it settles, the left column fires. This technique can improve duty-cycle ratings by as much as 40% compared with single-column designs. (Courtesy Dataproducts)

Print quality can be a subjective matter

manufacturers such as Dataproducts employ such techniques as dual-column (14-wire) printheads (Fig 2). In such a head, a wire in the first column fires, then settles; a second-column wire then fires and settles, and the process repeats. This method greatly enhances both printing speed and printhead life (as high as 300 million characters) and permits duty cycles 25 to 40% longer than possible with single-column designs.

No standards for forms

Because not all printing occurs on single-sheet paper, a printer's accommodation of multipart forms can also bear on its choice. Unfortunately, no standards govern the materials used in forms or the forms' thicknesses. Thus, there's really only one method of determining how well a printer handles a form: Try it.

However, you can look for certain basic attributes:

- An adjustable carriage that accommodates forms with varying thicknesses and widths. Typically, expect a maximum specified form thickness of 0.028 in., which includes an original and seven copies. Most printers can handle form widths ranging from 3 to 16 in.
- An adjustable line-spacing mechanism (6 or 8 lpi) to aid in matching lines on the form
- A printhead that moves across the paper freely

without touching the form and producing unwanted lines, yet provides sufficient force to print all forms.

Murphy's Law always being operative, though, after ensuring that a printer meets all these criteria, you'll probably encounter a form that somehow defeats it. Unfortunately, there's nothing you can do to avoid such disappointments, other than take as many precautions as possible. Microdata's Barny even suggests that you attempt to print on cardboard.

Three factors govern printing speed

Related intimately to printer choice is the question of speed touched on earlier. Basically, three factors underlie this consideration: print rate, throughput (number of lines per minute) and input data rate.

The print rate, measured in characters per second, tells how many characters can be placed on the paper per unit time. The quantity depends primarily on the print technology and the type of carriage mechanism. To put these factors into perspective, picture the printhead mounted on a carriage that moves parallel to the plane of the paper. The number of characters printed per second is then a function of how fast the print mechanism fires and the mechanism's speed of horizontal travel along a given print line. Note that the carriage's horizontal speed and the printhead's firing rate must remain totally in sync; when one leads or lags the other, characters are overlapped or disproportionately spaced. Several tests help determine whether a printer is properly timed in this regard (see box,

Checking printer timing

To ensure that a printer you're evaluating is correctly timed, you can perform a simple test that checks the relationship of printhead timing to horizontal carriage movement.

Print a line of capital Es—40 to 132 columns. Then overprint the same line four times. Skip down to the next line and repeat the process until you've printed a full page (66 lines). If the printer allows you to change pitch (the number of characters per inch), repeat the test for the higher setting.

Now look down at the lines of Es. All of the characters should line up; there should be no overlapping or "rivers" of white space arising from poor spacing.

Wavy lines in a printer's output result from faulty vertical stepping motion of the paper. To test a printer for correct vertical motion,

perform the same test as described above, except this time print each line just once, altering the data-input rate and the print rate for each new line. Each line should be free of wavering, and the leading (distance from the bottom of one line to the top of the next) should remain constant (0.10 to 0.16 in. typ).

If the printer can produce expanded characters, repeat both tests in that mode. This provision proves necessary because the timing changes for expanded printing: The head fires more frequently, and it can produce misregistration.

Indexing critically affects a printer's form-feed capability: On issuance of a form-feed command, the paper should advance from the top of the form to the same point at the top of the next sheet. And when the printer advances from

the last line to the top of the next form, the index point should also remain the same.

The test for form-feed indexing is simple. Print a letter at the top of the form, then issue a form-feed command and print the same character again. Continue this test for the printer's rated duty cycle, then match the print zones. In every case, the characters printed should line up at the same point.

Although these tests are time consuming, they will assist you in determining a printer's operating efficiency. Furthermore, they will either prove or disprove the manufacturer's reliability claims. Less expensive printers, such as those designed for the low-end hobby market, usually won't stand up to the tests. Consequently, choosing a low-end printer strictly on the basis of price can ultimately be a costly proposition.

"Checking printer timing").

For dot-matrix printers, print rate further depends on the number of wires in the printhead, the arrangement of those wires and the number of dots (7×7 , 9×9 , etc) in the character font. Most specified rates don't include head turnaround and line feed.

Illustrating these considerations, the Centronics Model 704 dot-matrix printer, with a single-column 9-wire head, has print rates of 180 cps for a 7×7 font and 165 cps for a 9×7 or 9×9 font. Dataproducts' Model M-200, with its dual-column 14-wire head, achieves 340 cps with a 7×7 font. Among fully-formed-character printers, Pertec's Model P360 daisy-wheel unit has an extremely slow print rate of 17 cps, while NEC Information Systems' Model 5500D thimble-mechanism printer scoots along at 55 cps.

The slower print rates of fully-formed-character printers arise from the printer design's basic physics and the need for the mechanism to come to a complete stop before printing a character. Factors of particular importance in these printers include head acceleration and deceleration, type-finger settling time and character indexing on the wheel or thimble (the latter mechanism requires the least time). Typically, for a 55-cps fully-formed-character printer, printing one character takes approximately 18 μ sec. Contrast this figure with the 5.5 μ sec required by a 180-cps 7×7 dot-matrix printer, which needs no character indexing

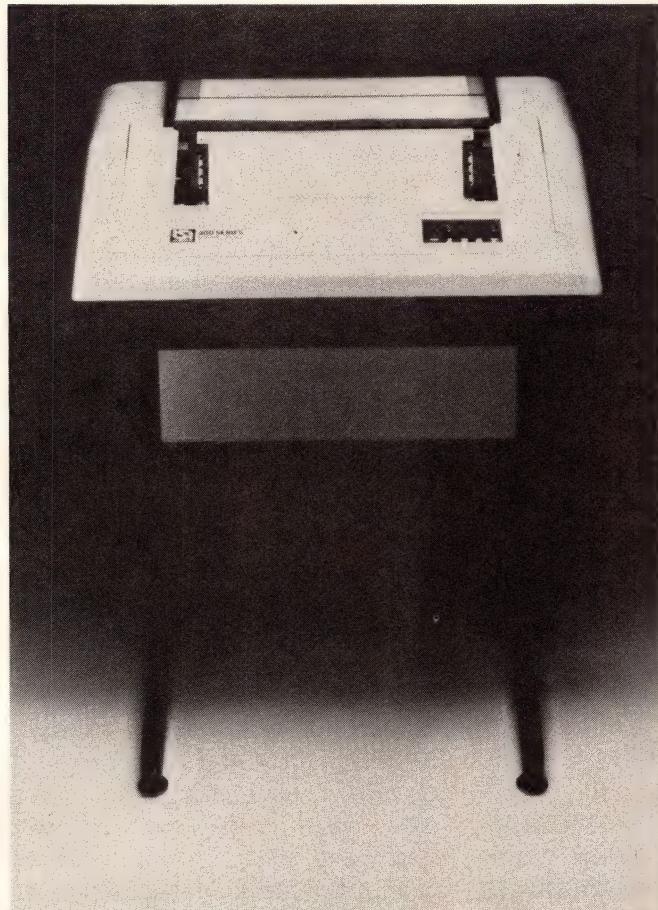
and printhead deceleration—it prints characters on the fly. (Interestingly, a single-column 9-wire head, printing 165 cps in a 9×9 font, requires approximately the same time, and a dual-column 14-wire head operating at 340 cps requires only 2.9 μ sec).

Turning now to printer throughput, note that this quantity varies with the printed format. But other factors also affect it. For example, printers with logic-seeking capability direct the head to the optimum starting point for each print line, either in the forward or reverse direction, and thus improve throughput.

Three interface choices

Input data rate, the third factor governing print speed, is intimately related to printer-interfacing considerations. Three interfacing methods exist: 8-bit parallel, RS-232C serial and Centronics compatible. The latter interface, a de-facto standard, is an 8-bit-parallel method with special pinouts. Centronics bases its compatibility on a 36-pin D-type connector, although the firm does offer some printers (such as Model 737) with a 40-pin pc edge connector.

An important aspect of a printer's interface is that the unit, as delivered, might not provide pinouts compatible with your host. In such cases, you must either redesign the interface on the host or implement one in the printer. But the amount of space available inside the printer can in some cases block the second



To reduce noise, Lear Siegler provides an optional acoustic quieting cover for its Model 310 Ballistic printer. The option reduces the printer's noise level from 71 to approximately 55 dB.



Utilizing a single-column 9-wire printhead and a 7×9 matrix, Hewlett-Packard's Model 2361G offers raster graphics, an IEEE-488 interface and print speeds as high as 180 cps. HP also offers alternative character sets for eight languages, Roman extension, math symbols and a special high-density font.

Check out forms handling by trying as many forms as possible

approach, especially in units shipped with parallel interfaces and requiring a serial add-on.

Although RS-232C defines an electrical standard for serial connection, it leaves room for designer choices. Thus, not all RS-232 interfaces are the same, especially with regard to handshaking. Generally, look for a version that accepts X-on/X-off signals to select or deselect the printer and to avoid character losses arising from a full buffer.

Regardless of the interface type, the input data rate

relates to how fast the printer can process characters and therefore determines how frequently the printer and host must handshake. Printers with small buffers must obviously handshake more often; those with large FIFO buffers require less frequent handshaking and thus have better overall throughput.

Also consider the protocols a particular printer accommodates. Such a protocol specifies the method of selecting or deselecting the printer and the method of data transmission. In general, look for one start bit, seven data bits, one parity bit (frequently not used) and one or two stop bits in a 10- or 11-bit data word.

μP control supports printer functions

You might suspect that intelligence also plays a major

Sheet feeders improve printer productivity

As greater numbers of small systems incorporate word-processing capability, the need to handle a variety of forms becomes increasingly important. One of the most difficult to handle of these forms is the cut sheet (letterhead paper); consequently, printer systems houses are now incorporating single or dual sheet-feeder mechanisms into their offerings.

Currently, the number of sheet-feeder-mechanism manufacturers is small; three companies dominate the market. All three firms—BDT (West Germany), Rutishauser Data AG (Stafa, Switzerland and Dallas, TX) and Advanced Terminals Inc (Mohawk NY)—offer products designed for incorporation into fully-formed-character printers.

Advanced Terminals (ATI), for instance, manufactures the Insert-a-Matic. This single-sheet unit, priced at \$1600, uses firmware for system control and comes with either a parallel or serial interface. ATI will also introduce Model 5000 in April; this unit will incorporate dual bins for handling letterheads and second sheets, use coded cartridges that permit operation with a printer serving more than one workstation and accept paper up to 14 in. wide and 14 in. long. A built-in collator, tractor feeds and a sound-damping enclosure, plus 8048-μC control, complete its list of features.



Permitting the use of cut or continuous forms, the Insert-a-Matic sheet feeder from Advanced Terminals Inc ensures precise registration by means of photo-sensed top-of-form detection and left-margin column-zero registration with adjustable format.

Dave Miller, ATI regional manager, says Model 5000 will carry a list price of approximately \$3300. It will allow a designer to incorporate a print mechanism right in the feeder and will sense the coded paper cartridges and inform the operator whether the proper paper is loaded.

Rutishauser USA offers a low-cost single- or dual-bin feeder. Versions include the Dataproducts-compatible RS-907, Diablo RS-901, Qume RS-903 and NEC RS-908; their differences are in platen widths and gear locations.

These units range in price from \$1500 to \$1550.

The Rutishauser feeders use a Mostek MK3870 1-chip μC that synchronizes paper movement with printing speed. A photocell recognizes the paper's leading edge. The printer need supply only power and ground; the platen provides the movement.

The BDT feeders, marketed by MQI Computer Products (Fountain Valley, CA), are available in several versions, including the \$1495 ASF 160. This single-bin feeder is an electromechanical design and utilizes the platen's forward and reverse motion to pick up sheets of paper.

For applications requiring dual bins, BDT offers the \$2195 ASF 171 and 176; the latter is totally mechanical, while the former uses an 8-bit μP designed by BDT specifically for paper handling. Both models accommodate as many as 250 sheets per tray.

Even though sheet feeders are extremely expensive when measured against the overall price of a printer system, they could soon grow less expensive. A \$500 mechanism might be just around the corner, sparked by the needs of word-processing systems and by printer manufacturers' desire to offer more OEM options. The Japanese have not yet entered the sheet-feeder business, but they are investigating the market's requirements.

role in printer choice. After all, to provide optimum operating efficiency, especially in small μ P-based systems, a printer should be able to handle most of the work with minimum host support. Therefore, OEMs call for units with processor control of such print functions as horizontal and vertical tabbing, number of lines per inch, form feed, skip of perforation, character sets and interface protocol. Manufacturers are employing the 8080A μ P and 8048 and 8049 1-chip μ Cs, as well as proprietary 8-bit devices designed specifically for printer control, to meet these needs.

Interestingly, though, many system designers consider the matter of implanted intelligence a minor issue: It's easy to find the intelligence you need. However, as you shop for a printer, it's appropriate to inquire about the unit's method of control and determine whether it does indeed fit your requirements.

Graphics/plotting capability proves useful

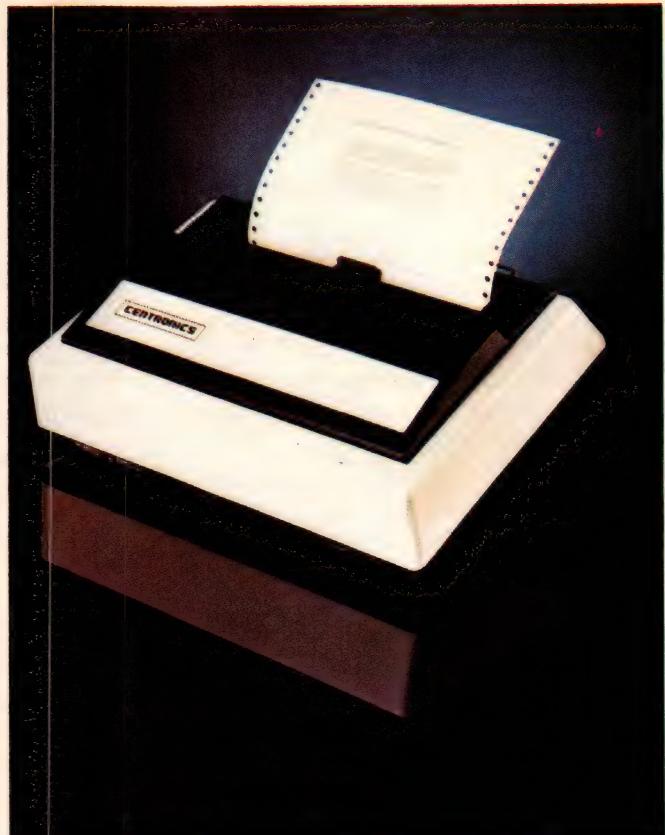
Directly related to a printer's intelligence is its ability to print graphics and perform plotting functions. A PROM-programmed μ P controls these functional character sets, interpreting the host's commands and determining which graphics or plotting function to implement.

OEMs are realizing that these functions are important in some applications. However, they don't consider the functions' presence or absence to be the major printer selection factor. Designers of word-processing systems do point out, though, that plotting is beginning to play a more important role, especially in applications requiring the creation of specialized reports. They observe that the incorporation of plotting implies heavy software support, even though printers exhibiting this feature implement it in firmware.

Graphics features appear to be more important to manufacturers and users of personal-computer systems; they consider the ability to print the contents of screens filled with either TRS-80- or Apple-style graphics of prime importance. As a result, manufacturers such as Centronics, Epson and Okidata are incorporating these graphics sets as standard features in their low-end dot-matrix printers.

Graphics isn't necessarily the sole province of hobby printers or dot-matrix designs, though. For example, Qume (in its Sprint Series), Diablo, Dataproducts and NEC all offer graphics options on their fully-formed-character models. But dot-matrix printers seem to be leading the way in graphics. Amperex, for one, offers the Philips Models GP74 and DX486, which support raster-style graphics. And Florida Data's Model BNY produces color graphics with horizontal and vertical resolutions as high as 128 dots/in.

Possibly the manufacturer with the best track record in graphics printers, though, is Hewlett-Packard. Its HP2631G combines the capabilities of a high-performance serial printer with the ability to print raster-data-format graphics with 72×72 -dots/in. resolution. The 2631G employs logic-seeking bidirectional printing; one of its dual 256-byte buffers can be filling



Featuring high-density printing in a proportionately spaced $n \times 9$ dot matrix, Centronics's Model 737 measures $14.5 \times 11 \times 5$ in. and weighs 12 lbs, making it a possible choice for small desktop systems.



Featuring a stored-energy print mechanism, Florida Data's Model BNY dot-matrix printer utilizes a 2-pass 16×16 format and achieves dot-placement accuracy on the order of 0.002 in. It thus depicts graphics with vertical and horizontal resolutions of 128 dots/in.

Graphics/plotting options can prove useful

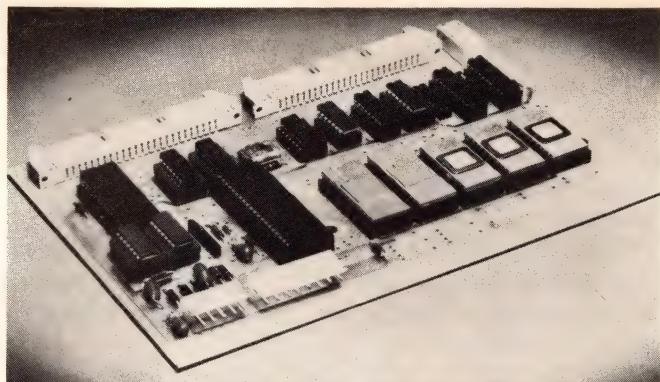
while the other is printing, thus improving throughput. The unit prints a 10×5-in. graphics picture in approximately 50 sec.

If you want graphics and/or plotting functions in a printer, you have several options other than buying a unit with those capabilities built in. For example, you can create your own firmware. But in that case you must take care that you don't defeat critical built-in timing patterns. Alternatively, you can request the vendor to create special firmware to meet your application requirements.

Another possibility is to buy personality cards from a third-party vendor. For example, Wilker Inc (Hayward, CA) offers an RS-232C-interface card designed for daisy-wheel printers. This Z80-based, \$700 (1000) Daisy Brain, Model DB200, has a 3k-byte memory and provides line and wrap justification, proportional spacing, centering, graphics/plotting capability, superscript/subscript capability, bold-face and shadow printing, and underlining and overstriking. It also supports data rates as high as 9600 baud, accommodates an X-on/X-off protocol and includes a 2k-byte buffer (expandable to 4k bytes).

Spare parts can prove troublesome

When shopping for a printer, you must also consider how easy it is to obtain spare parts for the unit you choose. Some printer manufacturers admit that salesmen will often advise you to buy an extra printer, from which you can cannibalize parts. They justify this advice by comparing the cost of a complete printer with the cost of spare parts, pointing out that parts are normally marked up by 100 to 150%. You can opt for this method of obtaining spare parts if you want to. But be aware that it's a double-edged proposition. If you purchase one spare printer for every one in the field, you'll not only waste money but will also have to send a bunch of stripped printers back to the manufacturer for refurbishing—a costly procedure.



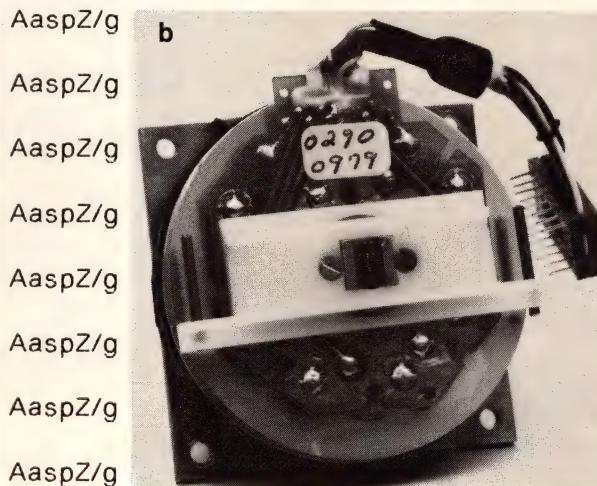
Providing added value, Wilker Inc's Daisy Brain DB200 communicates at up to 9600 baud and is compatible with any host computer or data terminal equipped with an asynchronous RS-232C serial port. The Z80-based interface adds high-resolution graphics and plotting capability to daisy-wheel printers such as the Qume or Diablo units.



Featuring a high-quality 11×7 serif font and 80-column output, Micro Peripherals' Model 88G supports a dot-addressable graphics option and sports a low \$525 (500) price.



Producing 120 to 216 cps in 1-pass fonts and 30 to 50 cps in 4-pass fonts, the Sanders Technology Media 12/7 (a) utilizes an infinite-matrix principle to achieve the desired print quality. The unit's μP-controlled printhead (b) can produce a variety of print fonts, such as Helvetica (left) and Presentation (right).

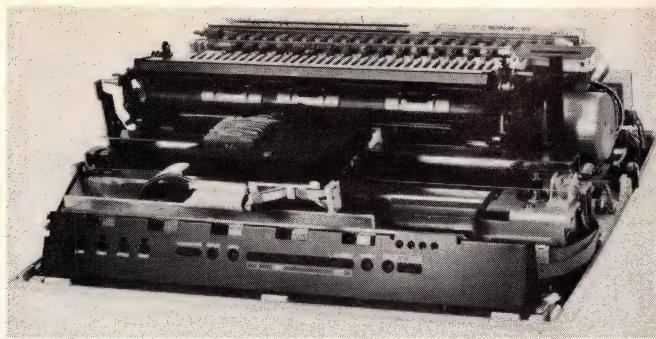


AASPZ/G

AASPZ/G

AASPZ/G

AASPZ/G



With an 18-wire replaceable printhead, Amperex Electronics's GP74 generates 9×7, 9×9, 18×25 (1-pass) and 36×50 (2-pass) matrices. It also provides 10-, 12- and 15-cpi pitches.



Daisy-wheel printers from Olivetti include Model DY 211 (lower right), which operates at 20 cps. Model DY 311 (left) achieves a peak speed of 38 cps, and Model DY 811 (upper right) outputs 80 cps. Prices range from \$1200 to \$2600; you can also buy the units in mechanism form.



Designed as a low-cost (\$28) throwaway replacement, this 9-wire single-column dot-matrix printhead is the heart of Epson's MX-80 tabletop printer.



Offering such standard features as 150-cps print speed, 1280-character buffer, 132-column adjustable carriage and the ability to print as many as six copies, Texas Instruments' Omni 820 RO supports applications requiring flexibility as data-processing requirements grow.

Fortunately, there's a more cost-effective method of obtaining spares. This method involves obtaining the manufacturer's suggested spares list and determining which items on it have the highest failure rate. Then purchase spares of those items, factoring in the number of printers you intend to buy and the leadtime required to obtain parts.

Additionally, even though buying a spare printer for spare parts isn't the most cost-effective method, don't discount the idea entirely. A good approach is to achieve a balanced mix of, say, one spare printer for every 50 in the field, plus a spares inventory that supports approximately 15 to 25% of the printers you buy. You can then use the spare printers either for a swapout or as a source of spare parts for those parts not currently in stock.

A diverse menu of product choices

With all the foregoing considerations in mind, you can go shopping for a printer. And you'll face a wide range of product choices. For example, consider the \$2295 (100) Qume dual-head TwinTrack Sprint printers, which employ dual daisy wheels mounted on one carriage. This technique produces print rates as high as 75 cps. Other features include 192-character lines in either 10- or 12-cpi pitch with proportional spacing in increments of $\frac{1}{120}$ in., accommodation of forms as wide as 28 in. and vertical spacing in increments of $\frac{1}{48}$ in. (up or down), with a slew rate of 4 ips.

NEC Information Systems offers a line of fully-formed-character printers that range in price from \$1430 to \$2555 (100). This Spinwriter Series achieves print rates between 35 cps (for Model 3500Q) and 55 cps (for Model 5525 KSR), using a thimble print mechanism. Buffer sizes range from 16 to 256 characters, depending on model. Bidirectional printing and fine-line plotting and graphics result from high-resolution positioning of $\frac{1}{120}$ in. horizontal and $\frac{1}{48}$ in. vertical—5760 plot points per in.²

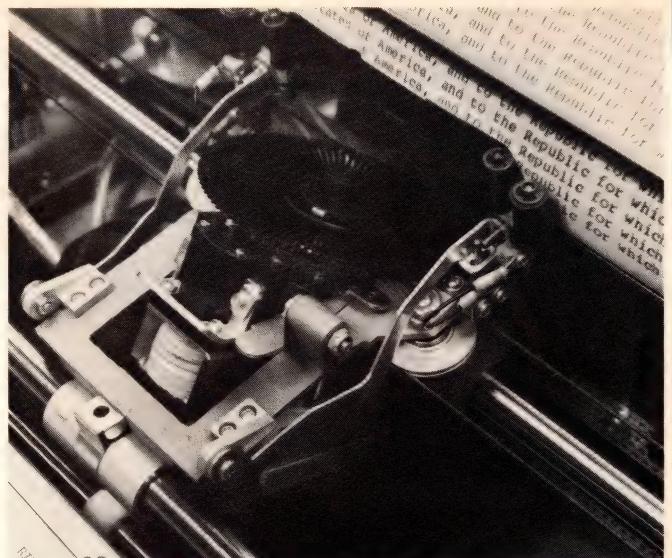
Another fully-formed-character printer is the Data-

Formulate a spares strategy that makes sense for you

products Model D-50. Priced at \$1665 (100) for the RO model, it employs a daisy-wheel mechanism. Its parallel interface is compatible with those of both Qume and Diablo printers; a serial RS-232C or 20-mA current loop is also available. The D-50 operates at 50 cps and produces 158 characters/line in 12-cpi-pitch mode or 196 with 15-cpi pitch; modes are software selectable. It achieves 11,520 plot points per in.² with resolutions of 120 positions/in. horizontal and 96 positions/in. vertical. The RO version measures 9×24.25×17.25 in. and weighs 57.5 lbs, allowing it to either fit on a stand or serve in a desktop environment. The unit's maximum noise level is 64 dB measured at 3 ft (see box, "Measuring printer noise output").

Dataproducts also serves the dot-matrix-printer market with its M-120 and M-200, priced at \$1620 and \$1810 (100), respectively. The M-200 employs a dual-column 14-wire dot-matrix head and functions as a bridge between serial impact units and line printers; it achieves a respectable 340-cps bidirectional print rate.

Perhaps the top-of-the-line dot-matrix printer for medium-duty-cycle (approximately 25%) applications, Texas Instruments' Model 810 costs approximately



To minimize downtime caused by carriage jamming, Dataproducts' Model D-50 KSR daisy-wheel carriage mechanism employs sealed journal bearings that require no lubrication.

\$1500 and employs a single-column 7-wire printhead. Its maximum print rate equals 150 cps. Although the 810 doesn't employ any new technology, it offers the advantage of a proven, widely used design for which a large amount of data exists.

Another notable dot-matrix printer is Infoscribe's \$910 (1000) Model 1000. Employing a single-column

The "bare-bones" alternative

Should you consider buying a printer mechanism rather than a complete printer? Unless you have extensive design resources, the answer is no: The required digital control circuitry and analog circuits (drivers for the head and steppers, speed-regulation servo loops, etc) can prove difficult to design.

Still, some designers choose this option. The experiences of Cado Systems (Torrance, CA) and Vector Graphic (Westlake Village, CA) prove enlightening in this regard.

Cado elected to vertically integrate its product line and was concerned that it couldn't find a printer to meet its needs. Consequently, the firm developed its own dot-matrix printer. It buys the basic print mechanism and adds value in the form of software and associated electronics.

Vector Graphic, on the other hand, developed a dot-matrix printer primarily to support its

in-house software development. This unit has a 7-wire print mechanism, prints 32 to 132 columns at 10 cpi and outputs 150 cps. Power and intelligence result from a parallel connection to the host bus. Chairman Robert Harp points out that although the design has met with reasonable success, it is not a cost-effective way of doing business. He considers buying a complete unit the more reasonable approach.

Centronics product manager Cyril Colbert takes a somewhat different view. He claims OEMs want a print mechanism, carriage and analog electronics and prefer to add value in the controller and formatter. This approach permits designers to create printers geared specifically to their needs.

Manufacturers such as C Itoh, Burroughs OEM Products, Teletype, Florida Data, Okidata, Olivetti and Victor Data offer a wide range of subsystems to serve those needs. For example,

consider Burroughs's PM 114 printer mechanism. This \$394 (100) device achieves bidirectional 90-cps printing with a \$58 9-wire single-column printhead that creates a 7×9 font. It accommodates continuous forms, roll paper or cut forms and incorporates analog drivers for the head, steppers and speed regulation.

If your design centers on data-logging or instrument applications, consider the mechanisms offered by such manufacturers as Hycom or Eaton LRC. For example, Hycom's \$101 (1000) Model DC-2106D uses an 8-wire nonimpact (electrostatic) printhead and prints on aluminized paper.

Eaton LRC's M-4 Series dot-matrix mechanisms, on the other hand, print on low-cost 40-column cash-register type paper. The units incorporate a 7-wire single-column printhead that provides a 5×7 format and generates 120 cps bidirectionally. They accommodate either spool or ribbon cartridges and are priced as low

Measuring printer noise output

How much printer noise can your application tolerate? When does noise become distracting or even harmful?

Regardless of print technology, impact printers typically exhibit noise figures ranging from 50 dBA to as high as 75 dBA (measured at 3 ft). The worst offenders are dot-matrix units, primarily because their heads make a buzzing sound.

Some manufacturers feel that printer noise level is reducible to less than 40 dBA. But until they achieve such noise reduction, you can deal with excessive noise by adding acoustic covers that you purchase separately or construct yourself. Alternatively, you can seek options such as that offered by Lear Siegler for the Model 310 Ballistic printer: A plexiglass cover with polyurethane foam padding reduces noise level from 71 to 55 dB.

9-wire head and a 9×9 font, it prints at 180 cps and incorporates a 1k-byte buffer, expandable to 4k.

And displaying a noteworthy difference in dot-matrix-printhead philosophy, Victor Data Products' \$725 (1000) Model 5080 data terminal uses a 7-wire solenoid-controlled print mechanism rather than a ballistic-type design. Director of marketing Ted Singer

points out that with this older technology, the firm achieves a life expectancy of 100M characters. And you can rebuild the \$70 head. Other features of Model 5080 include 100-cps print rate, graphics capability and compatibility with Hewlett-Packard's HP-IB interface.

The Japanese are entering the dot-matrix realm in a big way, as evidenced by such printers as Epson's \$355 (500) MX-80 and \$359 (100) MX-70. The latter model produces 40- to 80-character column widths and prints 80 cps. It uses the "throwaway" head employed in the MX-80. C Itoh, another Japanese firm, has targeted both the dot-matrix and fully-formed-character markets. The firm's Starwriter II 45-cps daisy-wheel printer and Comet II 136-column dot-matrix printer each cost less than \$1300 in OEM quantities.

Another recent entry into the OEM-printer market is Olivetti Peripheral Equipment's Model DM 80/180, a dot-matrix design employing a 16-pin printhead arranged in two 8-wire rows. This \$2500 (500) unit produces 180 cps with an 8×7 matrix and 80 cps with a high-definition 16×32 matrix. It develops the equivalent of fully formed characters on one pass in the high-density mode.

Furthermore, to provide true fully formed characters, Olivetti also offers three versions of a daisy-wheel unit. The \$1200 Model DY 211 outputs 20 cps and allows 10-, 12- and 15-cpi pitches, plus proportional spacing. The \$1600 Model DY 311, on the other hand, offers

as \$100 (500).

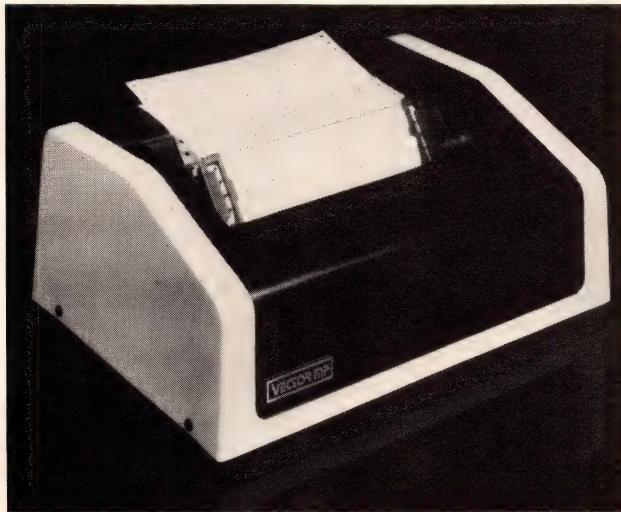
Faced with these product options, how can you decide whether to build, buy or add value when designing a printer system? Consider four key factors:

- Cost
- Your design expertise

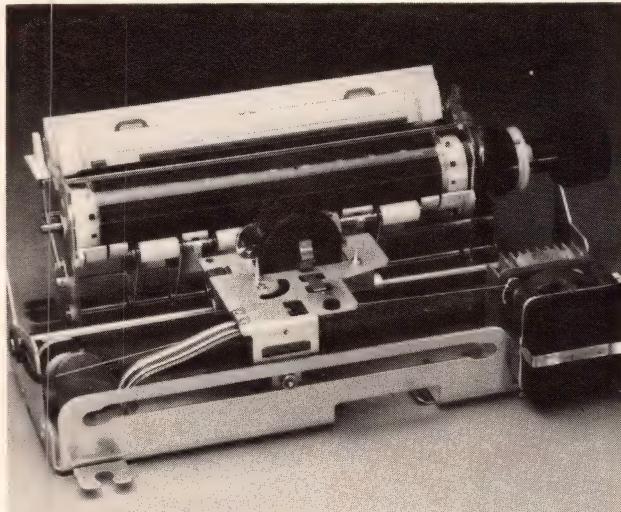
- Your ability to service what you design
- The ease with which you can vertically integrate an internally designed printer into your present operation.

Although carefully evaluating all of these factors will probably

prevent your making a costly mistake, consultant Andrew Roman (Newark, CA) offers some bottom-line advice: "Determine what the cost will be, now and later. There is really only one bottom-line decision factor—cost."



You can build your own printer, as Vector Graphic did. Model MP interfaces only to the manufacturer's system via the firm's Bitsreamer II parallel-interface card. Power and logic come from the host processor, providing a high degree of printer control at the expense of high host overhead.



For \$394 (100), you can buy this Burroughs OEM ballistic-head printer mechanism and build your own printer. The unit produces 132-character columns on 9 1/2-in. paper at 90 cps max.

Multiple printheads up speed but raise quality questions

print rates ranging from 32 to 38 cps, and the \$2600 Model DY 811 produces 65 to 80 cps. All three units have optional forms tractors and automatic sheet feeders. And to cover all the bases, Olivetti also

furnishes the DY 211 and DY 311 as print mechanisms only, with and without driving electronics (see box, "The 'bare-bones' alternative").

New technology spurs new designs

Some interesting technology innovations are available in today's serial impact printers—in both the fully-formed-character and dot-matrix realms. For example, consider the Pertec Stylist. This daisy-wheel

Manufacturers of serial impact printers

For more information on dot-matrix or fully-formed-character serial impact printers, contact the following manufacturers directly or circle the appropriate numbers on the Information Retrieval Service card.

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printer, manufactured by Triumph-Adler of West Germany, is compatible with the Adler and Royal typewriters—a feature that allows you to obtain supplies or spare parts from local typewriter dealers. The unit's 17-cps print rate is the penalty you pay along with the \$730 (1000) price. A sound-baffling design in the Stylist keeps noise levels below 62 dBa.

In the dot-matrix arena, manufacturers are using multiple printheads to improve throughput and charac-

ter quality. The method combines a low-resolution head with a high-resolution one: for example, a 7-wire unit with a 14- or 24-wire assembly. Other manufacturers are applying the same techniques to multipass printers: The first head creates the character, while the second overstrikes it with a half-dot offset. (Questions remain regarding this technique's viability, though; it appears that the method requires stopping the head each time to ensure precise dot registration. Thus, what you gain

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Integral Data Systems
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C Itoh Electronics
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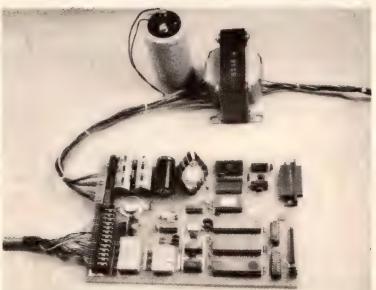
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Multipass printing calls for precise timing

in throughput on one end, you might lose on the other.)

The idea of multipass dot-matrix printing isn't new, but it hasn't been fully accepted, primarily because of mechanical problems associated with the design. Even though the technique's reliability currently is low, though, Dataproducts' Ron Morley cautions that you shouldn't write it off. He and others think that multiple-pass printing will eventually come into its own as printer manufacturers experience greater demand for high throughput and better quality. However, Dale Edwards, Lear Siegler's director of printer engineering, expects 1-column-printhead, 1-pass dot-matrix units to remain the high flyers for a long time. (Edwards admits he's biased, though: Lear Siegler's \$1545 (1000) Model 310 Ballistic printer employs a 1-column, 9-wire, single-pass mechanism.)

Sanders Technology has led the way in multipass printing. The firm's Media 12/7, priced at \$3995, is available with OEM discounts ranging from 38 to 40%, depending on quantity. It achieves print rates as high as 200 cps, depending on which of 100 fonts you choose. The printer's real selling point, though, is its print quality: As many as eight passes create the equivalent of a fully-formed-character printer's output. However, this quality is not without costs in system throughput, duty-cycle penalty and print-mechanism wear. And printer timing and registration are extremely critical; the firm compensates for the latter factor with a pin-fire PROM, keyed to each printhead, whose firmware takes into account the head's characteristics. (Thus, when you replace a head, you change the pin-fire PROM—adding to the printer's cost of operation.)

What's in store?

With at least 79 manufacturers offering serial impact printers, you'll have your hands full in making a selection, even if you're well prepared. And don't expect the decision-making process to get easier.

Complicating the process will be the use of specialized nonimpact printheads, such as R-Ohm's (Irvine, CA) thermal Model KG106. This head provides 203-dots/in. resolution, permitting the creation of very dense printing for graphics and facsimile applications.

Look, too, for decreases in printer size. And also expect to see even more emphasis on noise reduction with the introduction of tighter enclosures and less noisy print mechanisms.

However, don't expect to see any further major price reductions. Microdata peripherals VP Leonard Bleininger, for one, believes that pricing will stay fairly stable, even though more features will be available. **EDN**

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Programmable memories make product redesign easy

The latest programmable-memory introductions reflect advances to higher speed devices. But speed isn't the only improvement; new device types and options can aid your designs, too.

George D Huffman, Associate Editor

1980 was a good year for designers who must often change their minds—and thus their systems' memories. Three years before 1984 arrives, they can easily exercise Big Brother-like control—but on men's machines rather than their minds—thanks to the latest reprogrammable memories.

Nearly every semiconductor house regularly announces new erasable programmable memories (EPROMs) and their one-time-only fuse-link-programmable counterparts (PROMs). And as expected, EPROMs have continued their trend toward higher densities. Small-capacity memory users haven't been forgotten, though. In fact, two new low-capacity categories appear in this year's Programmable-Memory Directory: one headed by Motorola's MCM2801 (a 256-bit (16×16) word-alterable, electrically erasable (EEPROM) device), the other by General Instrument's ER4201 (an electrically alterable unit (EAROM) in the 1024-bit (128×8) class).

(Because EEPROMs and EAROMs are evolving so rapidly, EDN explores the newest of the devices and their future in detail on pg 57 of this issue, as well as listing them in this Programmable-Memory Directory. Also note that several devices listed in each category last year don't appear in this year's update.)

Shining some light on PROMs

Ultraviolet-erasable programmable memories (UV EPROMs) still account for the majority of new entrants in the directory. The density growth characterizing these parts is especially obvious in 32k-bit EPROMs. In addition to new second sources for the popular 2732, you'll find some interesting options for this device. For example, whereas many of the 2732-type devices listed in last year's tabulation didn't offer a Power Down mode, all of this year's additions do. Providing a 3:1 or 6:1 reduction in power-supply loading, that's a welcome option.

Perhaps more interesting is National Semiconductor's contribution to UV EPROMs. The firm's standard version, the NMC27H32, employs NMOS technology.

But unlike most other manufacturers' NMOS devices, its maximum access time is a very short 200 nsec—apparently achieved without special selection. The next-fastest units are Intel's HMOS 2732A and Texas Instruments' NMOS TMS2532-35, both of which spec 250 nsec max.

If speed isn't your prime concern and power-supply loading is, consider CMOS devices. National's CMOS UV EPROMs work more slowly than the firm's NMOS type by approximately a factor of two, but they aren't any slower than some other manufacturers' slowest NMOS units. And after all, when power consumption is critical, you must trade off a little speed. The CMOS devices require only 50 mW/MHz in Power Up mode (compared with the 750 to 850 mW required by NMOS) and a minuscule 125 μW in standby operation. In addition to providing these same CMOS-derived features in a 16-bit (2716) line, National plans to offer an NMOS-EEPROM version of the 2716 late this year.

As last year's directory anticipated, Intel has reached the 200-nsec speed barrier with the 64k-bit 2764-2 by employing an enhanced NMOS process, HMOS-II. And Motorola also expects great things from the HMOS process.

A look at the nearby figure shows what the firm is striving for in its near-future-planned memory products. If all goes according to plan, you can look for a fast 64k EPROM very soon and a very fast 128k device late this year or early in 1982.

Motorola's plans for packaging the 128k device haven't been revealed—if they've been finalized at all. Caught in the 24-vs-28-pin debate, the company has opted for 24 pins, while TI and Intel have adopted two different 28-pin configurations. (National, leaving nothing to chance, offers its devices in both TI's and Intel's configurations.)

But what about the problem of having only 24 pins to work with? At 32k-bit densities, 24 pins still work well

An effectively nonvolatile RAM results when an EEPROM backs up a RAM. The device's host computer uses the RAM portion under normal operating conditions, but if a crash is imminent, the EEPROM stores the RAM's contents. A 5V-only part, Xicor's X2201 RAM/EEPROM stores 1k bits.

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PCWD
ISU1

CMOS UV EPROMs challenge NMOS units in speed

enough; at 64k-bit levels, however, things become a bit crowded and some function MUXing proves necessary. And at 128k densities, 28-pin packages appear mandatory, especially if you want such niceties as output enable—a neat way of solving potential bus-contention problems—and a separate programming-pulse input. Only time and market pressure will resolve the 24-pin controversy, but at least Motorola's approach is coherent; the company's 24-pin 64k EPROM functionality resembles the TI device and plugs into the lower 24 pins of the 28-pin TI socket.

Additionally, Motorola always backs up any EPROM device with a directly compatible masked ROM. But keep in mind that because manufacturers' ROMs usually operate more rapidly than their EPROMs, you can't achieve the fastest possible data-throughput rate until the ROM replaces the EPROM in your system's final version. And don't forget the cost involved in substituting EPROM for ROM; it's not unusual for a UV EPROM to cost four to six times as much as the ROM you'll probably use in the end. Ease of design change has its price.

PROMs: the one-time-only memory

Unlike the various erasable and reprogrammable memories discussed so far, fuse-link-programmable (PROM) devices must be written correctly on the first try. (Actually, the remote possibility exists that some desired reprogramming might only entail blowing additional links.) And unlike masked ROMs or EPROMs, PROMs are really fast; maximum access times in the 50- to 80-nsec range aren't unusual. The fuse

technology used could be the limiting speed factor, however—a point speculated on by several manufacturers interviewed for last year's directory. In general, though, this year's device specs bear out last year's expectations: Titanium-tungsten (Ti-W) links do appear to permit faster memory operation, probably because of their lower inherent capacitance.

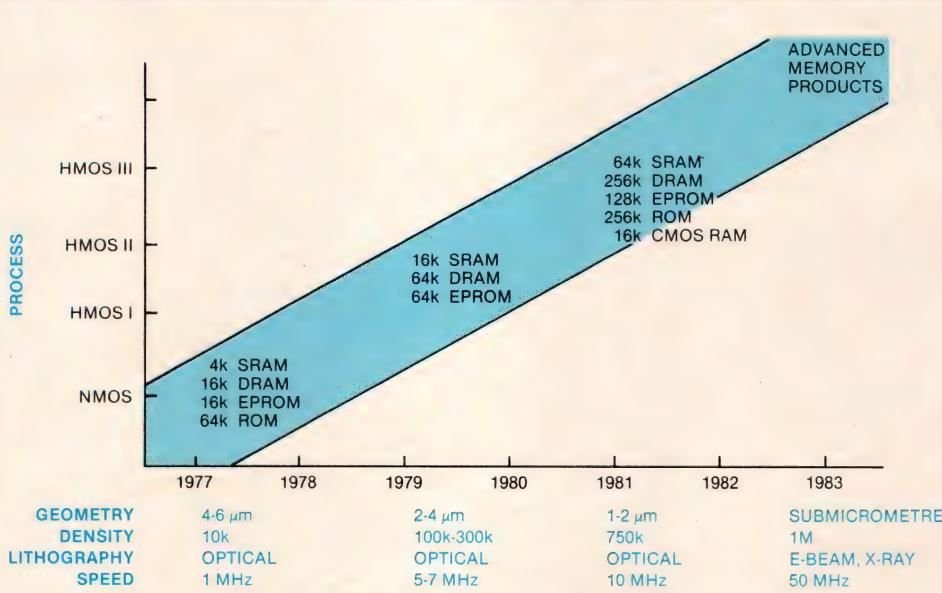
As was anticipated, little PROM-product activity has occurred at capacities above 16k. Last year's tabulation showed no products in the 32k class; this year's lists two. And in the 64k-PROM slot, only Harris has announced an entry, expected to become available in the third quarter.

The 8k and 16k PROM categories have received the most attention. Not only have more "no-frills" devices become available, but you can also obtain many of these basic types with assorted options. Power-down, low-operating-power and on-chip-register versions are appearing in greater numbers. Additionally, some of these enhanced devices come in 300-mil packages.

Tradeoffs among the options exist, too. In general, the low-power versions are the slowest but require only half as much operating power as other parts; power-down types fall into the middle speed range but still stand by at very low power levels. The on-chip-register versions, such as TI's 4k TBP28R45, spec an impressively short typical access time of 20 nsec. This figure could represent only the register's access time and not that of the PROM itself, however. If that is the case, the unit's actual overall access time could easily be longer than that of the apparently slower power-down type. The directory-update information provided by TI didn't clarify this point.

A guess about price and availability

When it comes to anticipating programmable-memory prices and availability, your guess is probably



By combining HMOS processing with fine-line geometries, Motorola can provide a wide range of memory products for the foreseeable future. A 64k UV EPROM is already available, and within a year, a 128k EPROM could appear.

Manufacturers of programmable read-only memories

For more information on PROMs, UV EPROMs, EAROMs or EEPROMs, circle the appropriate numbers on the Information Retrieval Service card or contact the following manufacturers directly.

Advanced Micro Devices
901 Thompson Pl
Sunnyvale, CA 94086
(408) 732-2400
Circle No 336

American Microsystems Inc
3800 Homestead Rd
Santa Clara, CA 95051
(408) 246-0330
Circle No 337

Electronic Arrays
550 E Middlefield Rd
Mt View, CA 94043
(415) 964-4321
Circle No 338

Fairchild Semiconductor
464 Ellis St
Mt View, CA 94042
(415) 962-5011
Circle No 339

Fujitsu Microelectronics Inc
2945 Oakmead Village Ct
Santa Clara, CA 95051
(408) 729-1700
Circle No 340

General Instrument Corp
Microelectronics Div
600 W John St
Hicksville, NY 11802
(516) 733-3000
Circle No 341

Harris Semiconductor
Box 883
Melbourne, FL 32901
(305) 724-7407
Circle No 342

Hitachi America Ltd
1800 Bering Dr
San Jose, CA 95112
(408) 292-6404
Circle No 343

Hughes Aircraft Co
Solid State Products Div
500 Superior Ave
Newport Beach, CA 92663
(714) 759-2411
Circle No 344

Intel Corp
3065 Bowers Ave
Santa Clara, CA 95051
(408) 987-8080
Circle No 345

Intersil Inc
10710 N Tantau Ave
Cupertino, CA 95014
(408) 996-5000
Circle No 346

Mitsubishi/Melco
3030 E Victoria St
Compton, CA 90221
(213) 537-7131
Circle No 347

Monolithic Memories Inc
1165 E Arques Ave
Sunnyvale, CA 94086
(408) 739-3535
Circle No 348

Mostek Corp
1215 W Crosby Dr
Carrollton, TX 75006
(214) 242-0444
Circle No 349

Motorola Inc
Integrated Circuit Div
3501 Ed Bluestein Blvd
Austin, TX 78721
(512) 928-6000
Circle No 350

National Semiconductor Corp
2900 Semiconductor Dr
Santa Clara, CA 95051
(408) 737-5000
Circle No 351

NEC Microcomputers Inc
173 Worcester St
Wellesley, MA 02181
(617) 239-1910
Circle No 352

Nitron Inc
10420 Bubb Rd
Cupertino, CA 95014
(408) 255-7550
Circle No 353

Oki Semiconductor
Suite 405
Santa Clara, CA 95051
(408) 984-4842
Circle No 354

Panasonic
1 Panasonic Way
Secaucus, NJ 07094
(201) 348-7276
Circle No 355

Plessey Semiconductors
1641 Kaiser Ave
Irving, CA 92714
(714) 540-9979
Circle No 356

Raytheon Semiconductor
350 Ellis St
Mt View, CA 94042
(415) 968-9211
Circle No 357

RCA Solid State Div
Rte 202
Somerville, NJ 08876
(201) 685-6000
Circle No 358

SGS-ATES Semiconductor Corp
240 Bear Hill Rd
Waltham, MA 02154
(617) 890-6688
Circle No 359

Signetics Corp
811 E Arques Ave
Sunnyvale, CA 94086
(408) 739-7000
Circle No 360

Synertek
Box 552
Santa Clara, CA 95051
(408) 988-5611
Circle No 361

Texas Instruments Inc
Box 225012, M/S 308
Dallas, TX 75265
Circle No 362

Toshiba America Inc
2151 Michelson Dr
Suite 190
Irvine, CA 92715
(714) 955-1155
Circle No 363

Xicor Inc
1221 Innsbruck Dr
Sunnyvale, CA 94086
(408) 734-3041
Circle No 364

Zilog
10460 Bubb Rd
Sunnyvale, CA 94086
(408) 446-4666
Circle No 365

as good as anybody else's.

When you compare this year's availability data with last year's, you'll notice that some of last year's announced products are still pending. In several cases, manufacturers have retracted devices; they're no longer available—if, indeed, they ever were. But if the directory still lists a device and the Availability column is blank, it's probably safe to assume the device exists—at least in some quantity. On the other hand, a newly listed device not accompanied by specific delivery data could mean one of two things: It exists now in quantity, or it doesn't exist at all and the manufacturer can't or won't say when it will.

Once you ascertain whether a device exists, the next trick is to obtain its firm selling price. But don't ask until you're ready to buy; price slashing in the memory marketplace—especially among EPROMs, it seems—is rampant. A Japanese firm's US-based semiconductor house, for example, recently announced price cuts spanning 45 to 65% for its 1k×8 and 2k×8 EPROMs. And if you negotiate a bit, you can probably reach an

even lower price. Unlike last year, manufacturers are reluctant to project "very little change in the pricing structure."

A year from now, when we next update this directory, you'll certainly find faster EPROMs listed. Not only will manufacturers further fine-tune the NMOS and HMOS processes, it's entirely possible they will tune CMOS-based memories so finely that the CMOS parts will become as fast as this year's NMOS units. But regardless of what happens in the access-time race, this year's optional features—power-down, low-power and various chip-select/enable functions—will likely become standard features. Improvements in both EEPROMs and EAROMs also seem inevitable—developments that will probably prompt manufacturers to develop fewer UV EPROMs.

EDN

Tables begin on pg 110

Article Interest Quotient (Circle One)
High 476 Medium 477 Low 478

UV-ERASABLE, ELECTRICALLY ALTERABLE AND ELECTRICALLY ERASABLE MEMORIES

SUPPLY VOLTAGES ③	OPERATION (STATIC/DYNAMIC) ④	POWER-DOWN MODE	POWER DISSIPATION (mW) ⑤		AVAIL IN 1981 ⑥	OTHER COMMENTS, INFORMATION, FEATURES ⑦	MANUFACTURER
			ACTIVE	STANDBY			
5V, 25V	D	●	165	22		WORD-ALTERABLE EEPROM	MOTOROLA
10V	D		28 (TYP)			EAROM; SERIAL I/O; 10-YR DATA RETENTION	NITRON
5V, -28V 5V, -28V	D D		400 500			EAROM; 5-BIT PARALLEL-BINARY ADDRESSING EAROM; 5-BIT BINARY ADDRESSING; WORD ALTERABLE	NITRON GI
5V, -28V 5V, -28V	D D		400 500			EAROM; NCR2055 SECOND SOURCE EAROM; 6-BIT BINARY ADDRESSING	NITRON GI
5V, 25V	D		400			EAROM; TTL COMPATIBLE	GI
5V, -12V	SEE COMMENTS		650			RAM WITH EAROM STORAGE; CE STROBES DURING RAM CYCLES	GI
5V, -15V	S		800			NONVOLATILE RAM WITH EAROM BACKUP	TOSHIBA
	S		275			NONVOLATILE RAM WITH EEPROM BACKUP	XICOR
-35V -35V	D		300			SERIAL EAROM; MOS COMPATIBLE	GI
5V, -9V	S		1W			100% MIL-STD-883 TESTING	AMD
5V, -9V	S		20(TYP)		1	1702 SECOND SOURCE IN CMOS	RCA INTEL
5V, -9V	S		885				NATIONAL SEMI
5V, 17V	SEE COMMENTS		7.5			EPPROM; CE USED AS CLOCK	HUGHES
5V, -12V ±5, 12V	D S S	●	30/60 900 800	5 µW			INTERSIL NATIONAL SEMI INTEL
5V, -12V ±5V, -14V	D		450			EAROM	NITRON
5V, -12V, -30	D		300			EAROM; 2402 HAS OUTPUT DATA STROBE	GI
5V, -12V SEE COMMENTS	D	●	450			EAROM; CE USED AS CLOCK	GI
5V, -12V ±5V, -14V	D	●	30/60	5 µW		SAME AS IM6654, M	INTERSIL
5V, 17V	SEE COMMENTS	●	7.5 20 (TYP) 50 50	1 500 µW 500 µW	20 1Q 3Q	EPPROM, CE USED AS CLOCK CMOS UVROM; 2708 PINOUT INTEL 2758 COMPATIBLE EPPROM; INTEL 2708 PINOUT	HUGHES
±5V, 12V	S		800			INTEL 2708 COMPATIBLE	RCA
±5V, 12V	S		900			INTEL 2708 COMPATIBLE	HARRIS
±5V, 12V	S		630			INTEL 2708 COMPATIBLE	HARRIS
±5V, 12V	S		475			INTEL 2708 COMPATIBLE	NATIONAL SEMI
±5V, 12V	S		750			INTEL 2708 COMPATIBLE	AMD
±5V, 12V	S		800			INTEL 2708 COMPATIBLE	EA
±5V, 12V	S	●	446	131			INTEL
±5V, 12V	S	●	446	131			INTEL
±5V, 12V	S	●	800			PIN 19 = 0V FOR 2758, 5V FOR 2759	FAIRCHILD
±5V, 12V	S	●	800				TI
±5V, 12V	S	●	525	132		INTEL 2708 PINOUT	TI
±5V, 12V	S	●	800			INTEL 2708 PINOUT	MOSTEK
±5V, 12V	S	●	800				MOTOROLA
±5V, 12V	S	●	525	132			MOTOROLA
±5V, 12V	S	●	580	132		LOW-POWER VERSION	MOTOROLA
±5V, 12V	S	●	580	132			NATIONAL SEMI
±5V, 12V	S	●	580	132			TI
±5V, -24V	D		250			SECOND SOURCE NCR 2810 EAROM	NITRON
±5V, -14V -23V	D		300				GI
	S	●	50	500 µW		INTEL 2716 PINOUT	HARRIS
	S	●	50	125 µW		CMOS VERSION OF 2716	NATIONAL SEMI
	S	●	50	125 µW		ABOVE WITH ADDRESS LATCH	NATIONAL SEMI
	S	●	750	150			NATIONAL SEMI
	S	●	450	125		EPPROM VERSION OF 2716	NATIONAL SEMI
	S	●	525	132			SYNERTEK
	S	●	750	132			NATIONAL SEMI
	S	●	525	132		INTEL PINOUT	AMD
	S	●	555	213		INTEL PINOUT	HITACHI
	S	●	300			EPPROM VERSION OF 2716; NO UV REQUIRED	HITACHI

Continued on next page

NOTES:

① TECHNOLOGY: MNOS = METAL NITRIDE OXIDE SEMICONDUCTOR (NONVOLATILE)

PMOS = P-CHANNEL MOS

NMOS = N-CHANNEL MOS

CMOS = COMPLEMENTARY

CMOS = COMPLEMENTARY-SYMMETRY MOS
HMOS = HIGH-SPEED, HIGH-DENSITY NMOS

HMOS = HIGH-VOLTAGE NMOS (DEVICE SCALING MATCHED WITH OPTIMUM PROCESSING METHODS)

HMO5-II = ENHANCED HMO5

② **MAX ACCESS TIME:** MAXIMUM ADDRESS-TO-OUTPUT-DELAY TIME OVER COMMERCIAL/MILITARY TEMPERATURE RANGE (0 TO 75 °C / -55 TO +125 °C)

③ **SUPPLY VOLTAGES:** PERTAINS TO DEVICES REQUIRING OTHER THAN A NOMINAL SINGLE 5V SUPPLY; VALUES INDICATED ARE NOMINAL, ± 5% FOR COMMERCIAL, ± 10% FOR MILITARY.

SUPPLY VOLTAGES ③	OPERATION (STATIC/ DYNAMIC) ④	POWER-DOWN MODE	POWER DISSIPATION (mW) ⑤		AVAIL IN 1981 ⑥	OTHER COMMENTS, INFORMATION, FEATURES ⑦	MANUFACTURER
			ACTIVE	STANDBY			
+5V, 12V +5V, 12V +5V, 12V	S	●	525	130	20	INTEL PINOUT INTEL PINOUT -55 TO +100°C	EA
	SS	●●	525	132		SECOND SOURCE TI	FUJITSU
	SS	●●●	525	132		SECOND SOURCE TI	INTEL
	SS	●●●●	632	165		SECOND SOURCE TI	INTEL
	SS	●●●●●	525	132		SECOND SOURCE TI	FAIRCHILD
	SS	●●●●●●	525	132		SECOND SOURCE TI	TI
	SS	●●●●●●●	525	132		SECOND SOURCE TI	TI
	SS	●●●●●●●●	525	132		SECOND SOURCE INTEL	MOSTEK
	SS	●●●●●●●●●	525	132		SECOND SOURCE INTEL	MOSTEK
	S	●	700	132		EEPROM, BYTE AND CHIP ERASE	MOTOROLA
+5V, 12V	S	●	800	131	40	INTEL PINOUT INTEL PINOUT	MOTOROLA
	SS	●●	525	131		INTEL PINOUT INTEL PINOUT	MOTOROLA
	SS	●●●	525	131		INTEL PINOUT INTEL PINOUT	MOTOROLA
	SS	●●●●	720	132		EEPROM, BYTE AND CHIP ERASE	TI
	S	●	495	132		EEPROM, BYTE AND CHIP ERASE	INTEL
	S	●	750	165		INTEL PINOUT TI PINOUT	NATIONAL SEMI
	SS	●	750	165		TI PINOUT	NATIONAL SEMI
	SS	●●	750	165		INTEL PINOUT	NATIONAL SEMI
	S	●●●	788	158		INTEL PINOUT	HITACHI
	SS	●●●●	500	132		LOW-POWER VERSION OF TMS2532	HITACHI
	SS	●●●●●	840	131			FUJITSU
	SS	●●●●●●	840	131			TI
	SS	●●●●●●●	840	131			TI
	S	●●●●●●●●	788	158		INTEL PINOUT	MOTOROLA
	SS	●●●●●●●●●	840	131		INTEL PINOUT	MOTOROLA
+5V, 12V	S	●●●●●●●●●●	50	125 µW	3Q	CMOS VERSION OF 2732	EA
	S	●●●●●●●●●●●	50	125 µW		AS ABOVE WITH ADDRESS LATCH	AMD
	S	●●●●●●●●●●●●	840	131			INTEL
	S	●●●●●●●●●●●●●	840	131			INTEL
	S	●●●●●●●●●●●●●●	787	341			NATIONAL SEMI
	S	●●●●●●●●●●●●●●●	787	158			NATIONAL SEMI
	S	●●●●●●●●●●●●●●●●	750	165			TI
	S	●●●●●●●●●●●●●●●●●	750	165			TI
	S	●●●●●●●●●●●●●●●●●●	840	131			TI
	S	●●●●●●●●●●●●●●●●●●●	840	131			TI
+5V, 12V	S	●●●●●●●●●●●●●●●●●●●●	840	131	40	JEDEC-STANDARD, ROM-COMPATIBLE PINOUT COMPATIBLE WITH MCM68366 ROM	INTEL
	S	●●●●●●●●●●●●●●●●●●●●●	840	132			MOTOROLA
	S	●●●●●●●●●●●●●●●●●●●●●●	840	131			MOTOROLA
	S	●●●●●●●●●●●●●●●●●●●●●●●	525	131			TOSHIBA
	S	●●●●●●●●●●●●●●●●●●●●●●●●	525	131			MOSTEK
	S	●●●●●●●●●●●●●●●●●●●●●●●●●	525	131			SYNERTEK

④ OPERATION: SOME DEVICES USE CHIP ENABLE (CE) TO STROBE INFORMATION IN AND OUT; REFER TO COMMENTS FOR DETAILS.

⑤ POWER DISSIPATION: UNLESS OTHERWISE NOTED, VALUES REFER TO MAXIMUM POWER DISSIPATION OF DEVICE WHEN ENABLED (ACTIVE) AND WHEN DISABLED (STANDBY). DEVICES WITH NO CHIP ENABLE ARE LISTED UNDER ACTIVE — NUMBERS IN THIS CASE REFER TO READ MODE; POWER DISSIPATION IS HIGHER IN WRITE MODE.

⑥ AVAIL IN 1981: LACK OF ENTRY SIGNIFIES CURRENT AVAILABILITY. ENTRIES TELL QUARTER IN WHICH SAMPLES WILL BECOME AVAILABLE. SOME DATA NOT AVAILABLE ON THESE LATTER DEVICES WHEN THIS DIRECTORY WAS COMPILED.

⑦ COMMENTS: UNLESS OTHERWISE NOTED, ALL DEVICES ARE UV-PROMs.

FUSE-LINK-PROGRAMMABLE, NONERASABLE MEMORIES

DENSITY (BITS)	ORGANIZATION (BITS)	TECHNOLOGY ①	FUSE TECHNOLOGY ②	PART NUMBER ③			NO OF PINS	MAX ACCESS TIME ④ (NSEC)	
				OPEN-COLLECTOR OUTPUT	3-STATE OUTPUT	ACTIVE PULL-UP OUTPUT		COMM	MIL
256	32×8	ST	PLAT	Am27S18	Am27S19		16	40	50
		LS	PLAT	Am27LS18	Am27LS19		16	50	65
		ST	Ni	6330-1	6331-1		16	50	60
		ST	AIM	5600			16	50	60
		ST	Ni	82S23	82S123		16	50	60
		ECL	Ni	10139			16	20	
		ECL	Ni	MCM10139			16	20	
		ST	Ti-W	TBP18SA030	TBP185D30		16	40	50
		ST	Ti-W	DM74S183	DM74S288		16	35	45
		ST	Ni	HM7602	HM7603		16	50	60
512	64×8	ST	Ni	HPROM0512			24	140	140
1k (1024)	256×4	ST	PLAT	Am27S20	Am27S21		16	45	60
		ST	Ni	6300-1	6301-1		16	55	75
		TT	AIM	5603			16	60	180
		CMOS	POLY	HM7610A	HM6611		16	450	
		ST	Ni		HM7611A		16	45	65
		LS	Ni	82S126	29663		16	55	70
		ST	Ni	10149	82S129		16	55	75
		ECL	Ni	MCM10149			16	20	
		ECL	Ni	TBP24SA10	TBP24S10		16	25	
		ST	Ti-W	DM74S387	DM74S287		16	55	75
2k (2048)	256×8	ST	Ti-W	TBP28LA22	TBP28L22		20	70	75
		ST	Ni	6308-1	6309-1		16	70	80
		LS	Ni		29603		20	60	75
		ST	Ni		82S114		24	45	60
	512×4	ST	Ni	93436	93446		16	50	60
		ST	PLAT	Am27S12	Am27S13		16	50	60
		ST	Ni	6305-1	6306-1		16	60	75
		TT	AIM	5604			16	70	90
		ST	Ni	HM7620A	HM7621A		16	50	70
		LS	Ni		29613		16	55	70
4k (4096)	512×8	ST	Ni	82S130	82S131		16	60	75
		ST	Ti-W	DM74S570	DM74S571		16	55	65
		ST	Ni	93438	93448		24	55	70
		ST	Ni	MCM7640	MCM7641		24	70	85
		ST	Ti-W	TBP18SA42	TBP18S42		20	75	85
		ST	Ti-W	TBP18SA46	TBP18S46		24	75	85
		ST	Ni	82S146	82S147		20	45	
		ST	PLAT	Am27S30	Am27S31		24	55	70
		ST	PLAT	Am27S26	Am27S27		22	SEE COMMENTS	
		ST	PLAT	Am27S28	Am27S29		20	55	70
		ST	Ti-W	74S473	74S472		20	55	70
		ST	Ni	6348-1	6349-1		20	70	80
		ST	Ni	6340-1	6341-1		24	70	80
		TT	AIM	5605			24	70	90
	1024×4	CMOS	POLY	HM7640A	HM6641		24	200	200
		ST	Ni		HM7641A		24	50	70
		LS	Ni	HM7648	HM7649		24	60	75
		LS	Ni	29620	29621		20	65	80
		ST	Ti-W		TBP28L42		20	60 (TYP)	
		ST	Ti-W		TBP28L45		24	60 (TYP)	
		ST	Ti-W		TBP28P42		20	35 (TYP)	
		ST	Ti-W		TBP28P45		24	35 (TYP)	
		ST	Ti-W		TBP28R45		24	20 (TYP)	
	1024×4	ST	Ni	93452	93453		18	55	70
		ST	Ni	MCM7642	MCM7643		18	70	85
		ST	Ti-W	TBP24SA41	TBP24S41		18	55	
		ST	Ni	82S136	82S137		18	60	
		ST	DEAP		MB7122		18	45	60
		ST	PLAT	Am27S32	Am27S33		18	55	70
		ST	POLY	3605A,-1	3625A,-1		18	60, 50	
		ST	Ni	6350-1	6351-1		18	60	75
		ST	Ni	6352-1	6353-1		18	60	75
		ST	Ti-W	5163RA441			18	65	
		ST	Ni	HM7642A	HM7643A		18	50	60
					HM7644		18	60	85

POWER-SUPPLY CURRENT ^⑤ (mA)		POWER SWITCH ^⑥	AVAIL IN 1981 ^⑦	OTHER COMMENTS, INFORMATION, FEATURES	MANUFACTURER
ACTIVE	STANDBY				
115 80 125 100 125 150 130 110 110 130				MOTOROLA COMPATIBLE	AMD AMD MMI INTERSIL SIGNETICS SIGNETICS MOTOROLA TI NATIONAL SEMI HARRIS
100			10		HARRIS
130 130 130 10 130 130 130 130 120 125 100 130	100 µA	● ●		STATIC; TTL COMPATIBLE; CMOS-RAM PINOUT (EXCEPT PE) SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE MOTOROLA COMPATIBLE	AMD MMI INTERSIL HARRIS HARRIS RAYTHEON SIGNETICS SIGNETICS MOTOROLA TI NATIONAL SEMI
100 155 130 130		●	20	SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE SECOND SOURCE TO HARRIS 7629	TI MMI RAYTHEON SIGNETICS
100 130 130 140 130 130 130 130 130		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE	FAIRCHILD AMD MMI INTERSIL HARRIS RAYTHEON SIGNETICS NATIONAL SEMI
175 140 155 155 155 175 185 160 160 155 170 185 10 mA/MHz 170 170 170 155 50 (TYP) 50 (TYP) 100 100 110 (TYP)	100 µA		30 20 10 10 10 10 10	BUILT-IN PIPELINE REGISTER: ADR TO CLK SET UP = 40 NSEC, CLK TO OUTPUT = 15 NSEC SECOND SOURCE FOR AMD 27S28/9 PIPELINE PROM; PINOUT LIKE BIPOLAR 7641; ON-CHIP ADDRESS LATCHES SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE LOW POWER LOW POWER IN 300-MIL PACKAGE POWER DOWN POWER DOWN IN 300-MIL PACKAGE ON-CHIP REGISTER, 300-MIL PACKAGE	FAIRCHILD MOTOROLA TI TI SIGNETICS AMD AMD AMD NATIONAL SEMI MMI MMI INTERSIL HARRIS HARRIS RAYTHEON HARRIS RAYTHEON TI TI TI TI TI TI TI
170 140 140 140 145 145 145 175 175 120 140 140	12	● ●	20	COMPATIBLE WITH 82S137, HM7643 & 6353-1 SAME AS 6350 BUT DIFFERENT PINOUT REGISTERED PROM; ASYNC ENABLE; RS VERSION HAS SYNC ENABLE	FAIRCHILD MOTOROLA TI SIGNETICS FUJITSU AMD INTEL MMI MMI MMI HARRIS HARRIS

Continued on next page

DENSITY (BITS)	ORGANIZATION (BITS)	TECHNOLOGY ①	FUSE TECHNOLOGY ②	PART NUMBER ③			NO OF PINS	MAX ACC TIME ④ (NSEC)
				OPEN-COLLECTOR OUTPUT	3-STATE OUTPUT	ACTIVE PULL-UP OUTPUT		
8k (8192)	1024 × 8	ST	Ni	93450	93451		24	55
			DEAP	TBP28SA86	MB7132		24	55
			Ti-W		TBP28S86		24	55
			POLY		3628, -4		24	80, 100
			Ni	MCM7680	MCM7681		24	70
			PLAT	Am27S180	Am27S181		24	60
			Ti-W	DM87S180	DM87S181		24	60
			Ni	6380-1	6381-1		24	90
			Ni	HM7680A	HM7681A		24	50
			LS		296357		24	70
			LS		296313		24	70
			ST	82S180	82S181		24	60
			ST	82S182	82S183		24	70
			Ti-W		TBP28L86		24	130
			Ti-W		TBP28L85		24	65 (TYP)
			Ti-W		TBP28P85		24	35 (TYP)
			Ti-W		TBP28R85		24	20 (TYP)
			PLAT		AM27S35		24	60
	2048 × 4	ST	Ti-W	TBP24SA81	TBP24S81		18	60
			DEAP		MB7128		18	55
			Ni	MCM7688	MCM7689		20	70
			PLAT	Am27S184	Am27S185		18	55
			PLAT		Am27S185A		18	35
			PLAT		Am27PS185		18	50
			Ni	HM7684A	HM7685A		18	60
			Ti-W	DM87S184	DM87S185		18	55
			Ti-W	5/63RA841			20	60
			LS	29650	29651		18	75
			ST	Ni	82S184	82S185	18	100
			ST	Ni	MCM7686	MCM7687	20	70
16k (16,384)	2048 × 8	ST	Ti-W	87S190	87S191		24	80
			Ni	HM76160	HM76161		24	60
			Ni		HM7616		24	60
			POLY		3636B-1, -2		24	35, 45
			Ti-W		TBP28P166		24	35 (TYP)
			Ti-W		TBP28L166		24	65 (TYP)
			Ti-W		TBP28R166		24	20 (TYP)
			PLAT		Am27S191		24	40
			PLAT		Am27PS191		24	50
			PLAT		Am27S291		24	50
			LS	Ni	29681, 3		24	80
			ST	Ni	82S190	82S191	24	80
			ST	Ni	63S1680	63S1681	24	70
			Ti-W		MCM76191		24	70
			Ti-W		TBP28S166		24	70
			Ni	93511	MB7138		24	35 (TYP)
			DEAP		3636, -1		24	80, 65
	4096 × 4	ST	PLAT	Am27S41A			20	40
			PLAT	Am27PS41			20	50
			Ni	HM76164	HM76165		20	60
								80
32k (32,768)	4096 × 8	ST	POLY		3632		24	40
		ST	Ni	HM76320	HM76321		24	65
64k (65,536)	8192 × 8	ST	Ni	93564/65				35 (TYP)
		ST	Ni	HM76640	HM76641		24	85

NOTES

① TECHNOLOGY: ST = SCHOTTKY TRANSISTOR-TRANSISTOR LOGIC (STTL)

LS = LOW-POWER SCHOTTKY

TT = TRANSISTOR-TRANSISTOR LOGIC (TTL)

ECL = Emitter-Coupled Logic

CMOS = COMPLEMENTARY-SYMMETRY METAL-OXIDE SEMICONDUCTOR

② FUSE TECHNOLOGY: Ni = NICHROME

Ti-W = TITANIUM-TUNGSTEN

PLAT = PLATINUM SILICIDE

POLY = POLYCRYSTALLINE SILICON

AIM = AVALANCHE-INDUCED MIGRATION (INTERSIL PATENT)

DEAP = DIFFUSED EUTECTIC ALUMINUM PROCESS (FUJITSU PATENT)

③ PART NUMBER: NUMBERS REFER TO COMMERCIAL-TEMPERATURE-RANGE ICs (0 TO 75°C). IN MOST CASES, MIL DEVICES ALSO AVAILABLE IF ACCESS TIME QUOTED UNDER MIL HEADING

POWER-SUPPLY CURRENT ⁵ (mA)	ACTIVE	STANDBY	POWER SWITCH ⁶	AVAIL IN 1981 ⁷	OTHER COMMENTS, INFORMATION, FEATURES	MANUFACTURER
175 155 135 190 150 170 170 180 170 170 170 175 175 100 55 (TYP) 110 120 (TYP)				2Q	COMPATIBLE WITH 82S185, HM7685, 63101-1 FOUR CHIP SELECTS	FAIRCHILD FUJITSU TI INTEL MOTOROLA AMD NATIONAL SEMI MMI HARRIS RAYTHEON RAYTHEON SIGNETICS SIGNETICS
125 175	12		●		SPROM VERSIONS REDUCE POWER BY 75% IN POWER-DOWN MODE SPROM AVAILABLE; HAS 4 GATED CHIP-SELECT LINES	TI TI
150 150 120 170 170 130 170 120	75		●	3-QQ 1Q	LOW POWER LOW POWER, 300-MIL PACKAGE POWER DOWN, 300-MIL PACKAGE ON-CHIP REGISTER, 300-MIL PACKAGE REGISTER PROM, 300-MIL PACKAGE	TI TI TI TI AMD
180 180 180 185 100 50 (TYP) 110 (TYP)	15		●	3-QQ 1Q 1Q 1Q	OUTPUT REGISTERS CS RECOVERS POWER IN 10 NSEC	FUJITSU MOTOROLA AMD AMD HARRIS NATIONAL SEMI MMI RAYTHEON SIGNETICS MOTOROLA
175 175 175 180 175 180 180 185	75		●	3Q 3Q 3Q 1Q 1Q	REGISTERED PROM; ASYNC ENABLE; RS VERSION HAS SYNC ENABLE SPROM VERSIONS AVAILABLE (REDUCE POWER BY 75%) OUTPUT LATCHES	SIGNETICS HARRIS NATIONAL SEMI MMI RAYTHEON SIGNETICS MOTOROLA
180 180 180 185 100 50 (TYP) 110 (TYP)	15		●	1Q 1Q 1Q 1Q	COMPATIBLE WITH HARRIS, SIGNETICS, MMI STANDARD 2716 PINOUT	HARRIS HARRIS INTEL TI TI TI
175 175 175 180 175 180 180 185	75		●	3Q 3Q 3Q 1Q 1Q	POWER DOWN, 300-MIL PACKAGE LOW POWER ON-CHIP REGISTER, 300-MIL PACKAGE SLIMLINE PACKAGE SPROM VERSIONS REDUCE POWER BY 75%	AMD AMD AMD RAYTHEON SIGNETICS MMI MOTOROLA TI FAIRCHILD FUJITSU INTEL
185					THREE CHIP SELECTS	
175 175 170	75		●	2Q	CS RECOVERS POWER IN 10 NSEC	AMD AMD HARRIS
185 190				3Q 3Q		INTEL HARRIS
190				4Q 3Q		FAIRCHILD HARRIS

④ **MAX ACCESS TIME:** MAXIMUM ADDRESS-TO-OUTPUT-DELAY TIME FOR COMMERCIAL (0 TO 75°C) AND MILITARY (-55 TO +125°C) DEVICES OVER FULL TEMPERATURE RANGE

⑤ **POWER-SUPPLY CURRENT:** MAXIMUM SUPPLY CURRENT DRAWN AT NOMINAL 5V SUPPLY VOLTAGE. STANDBY CURRENT, WHEN GIVEN, IS MAXIMUM CURRENT DRAWN WHEN DEVICE IS NOT ACTIVATED (IF APPLICABLE).

⑥ **POWER SWITCH:** BULLET INDICATES AVAILABILITY OF DEVICES THAT SWITCH TO POWER-DOWN MODE WHEN NOT ACTIVATED.

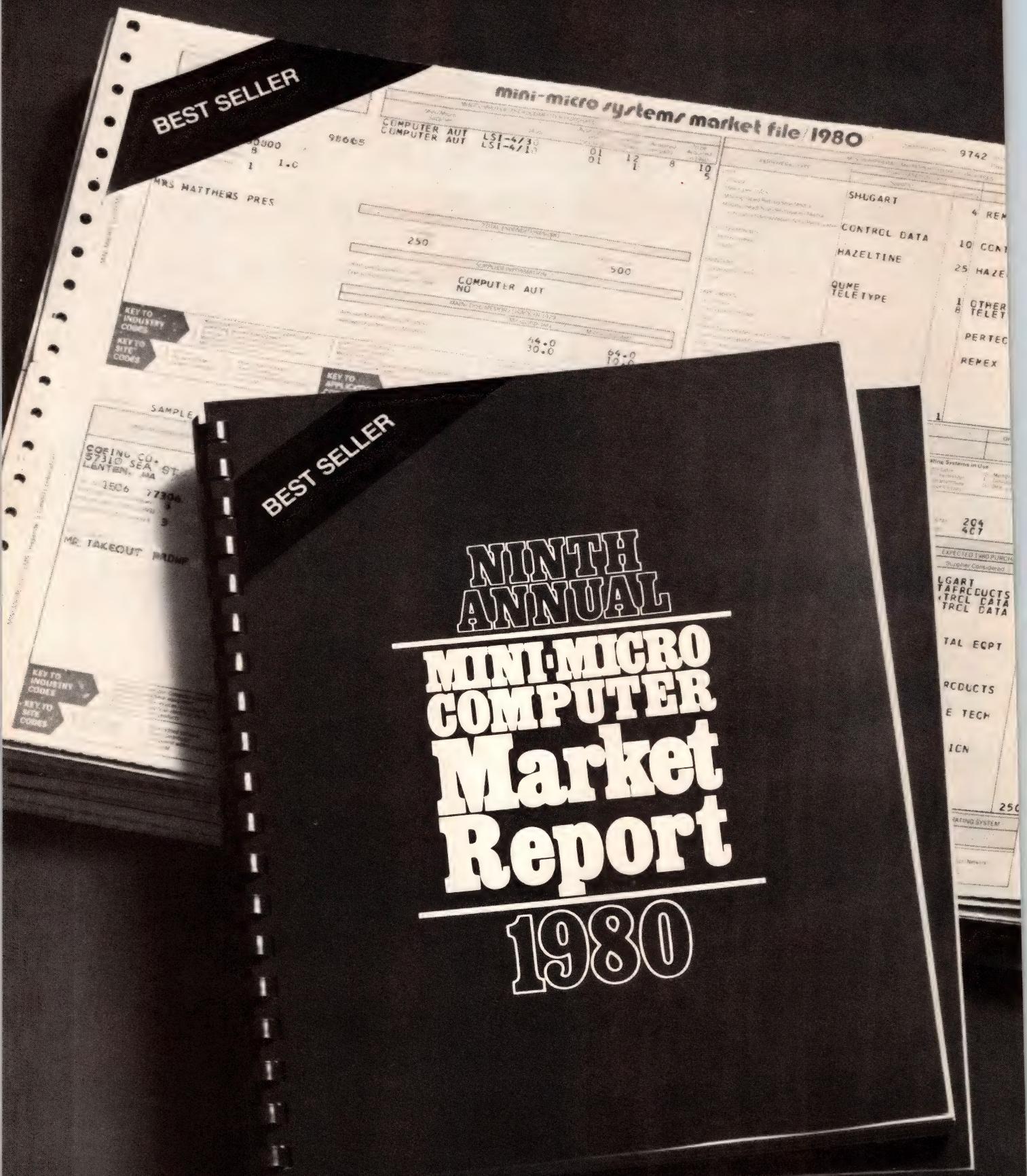
⑦ AVAIL IN 1981: LACK OF ENTRY SIGNIFIES CURRENT AVAILABILITY; ENTRIES TELL QUARTER IN WHICH SAMPLES WILL BECOME AVAILABLE. SOME DATA NOT AVAILABLE ON THESE LATTER DEVICES WHEN THIS DIRECTORY WAS COMPILED.

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11,024	15,613	Microcomputers	69,099
58,965	71,676	Alphanumeric CRT terminals	16,190
4,882	6,993	Graphic CRT terminals	24,737
6,002	7,451	Open reel tape drives	38,762
3,566	6,461	Tape cassette and cartridge drives	48,709
			3,126
			24,918
			3,528
			Data acquisition systems
			Modems

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Put theory into practice to motivate your design staff

Novice as well as experienced engineering managers must understand what motivates their employees before expecting increased productivity.

Haluk Bekiroglu and Carl Hutchison,
Eastern New Mexico University

One of the most challenging tasks facing you as a manager is finding ways to effectively motivate your subordinates. If individuals are intrinsically motivated, they can creatively use their energies to meet more productive goals. And from an organizational standpoint, because salaries and wages are usually a firm's largest expenditure, such increased *employee* productivity represents the greatest potential source of increased *organizational* productivity and profitability. Therefore, motivation is the key to both individual success and organizational effectiveness.

In the past, motivational methods usually consisted of traditional authoritarian approaches coupled with financial incentives. However, motivating today's employees with these methods alone has become increasingly difficult as employees become more economically secure and less dependent on any particular organization. Of course, financial rewards remain an integral part of organizational motivation—few people are willing to work for nothing. But the traditional authoritarian approach ("I'm the boss and you'll do as I say") is increasingly giving way to managerial theories and practices that take into account more of the employee's needs and expectations.

Theorists have described these needs and expectations, and their relationship to applied motivational techniques, from several perspectives. To effectively motivate *your* staff, you must understand these theorists' work and its implications.

Choose among three theories of motivation

Most currently popular motivational theories used by managers are termed need theories and are based on the premise that internal drives and motives are the primary causes of human action (Ref 3). One of the most popular theorists in this school, Abraham Maslow, states that human needs fall into two categories:

- Innate or primary—The unlearned needs that people are born with, including those centering on hunger, thirst, sex and safety

- Acquired or secondary—The needs that people learn to experience, including those for self esteem and self actualization (Ref 11).

In the workplace, wages and job security satisfy lower order needs, while intrinsic job satisfaction fulfills those of a higher order. The lower order needs must be substantially satisfied before higher order ones can serve as motivators.

Another theorist, Douglas McGregor (Ref 9), has developed two sets of assumptions concerning employees' attitudes toward work: Theory X and Theory Y. Theory X assumes that people basically dislike work and avoid it if possible, while Theory Y states that working is natural and that people generally work to the best of their ability. McGregor believes managers obtain the best results if they base their actions on the latter theory.

Still another theory, formulated by David McClelland and his associates (Ref 7), recognizes individual differences in three categories of emotional needs:

- The need to achieve, excel and succeed
- The need for affiliation and close interpersonal relationships
- The need for power.

Individuals' need levels in each of these three categories affect the way they approach their jobs and how well they do those jobs. For example, scientists and engineers generally have a high need to achieve, and that factor significantly accounts for their successful performance in research and development projects (Ref 13).

The foregoing motivational theories prove useful only insofar as you can successfully apply them. Consider which of the approaches (or which combinations of them) you can effectively apply to motivate your design-engineering staff.

First, briefly examine the engineering job itself to determine which approach to use. Engineering design has been defined as "a continuous process whereby scientific and technological information is used to innovate a system, device or process that will benefit society in some way" (Ref 6). The entire engineering structure is erected for the purpose of bringing into

being the designer's ideas (Ref 4). Design is a creative process more akin to invention than research; therefore, design engineers must combine a driving curiosity and willingness to explore the unconventional with the knowledge and skill they have acquired through education or previous experience. They work in a complex, dynamic, rapidly changing technological environment, generally alone or in small groups; thus, they are not required to communicate continuously with others (nor are they usually very much inclined to). Rather, they are much more interested in the technical and mechanical aspects of problem solving.

Design engineers, then, possess a self-disciplined creativity that allows them to become totally obsessed with whatever problem they are working on, never leaving it until they find a solution. They are often unconventional and do not compete with other people as much as they do with nature, materials and their own standards of quality (Ref 6). They are usually conservative, work and family oriented, self contained and independent. And although they can accept legitimate authority, they don't worship the powerful organization. They value financial rewards to an extent, but their source of pride and satisfaction stems from the challenge of creating something of quality and seeing it work. They are modern-day craftsmen (Ref 8) and realize the differences between themselves and other skilled workers in terms of job approach, personality traits, required supervision and goal setting (Ref 10). With regard to Maslow's theory,

intrinsic self fulfillment primarily motivates a design engineer.

Despite the predominance of engineers' higher order sources of motivation, a reasonably and equitably administered pay system is crucial to their morale and long-term productivity. Therefore, a company should design a pay system to fit both its needs and those of its employees. Some general characteristics of a good pay plan include:

- Periodic and scrupulously fair appraisals of each individual's performance. These appraisals serve as a basis for promotions and salary increases.
- Fairness in evaluating the job compared with other jobs in the organization. Employees must feel that what they receive for doing their jobs is fair relative to the compensation other employees receive for their work.
- An incentive compensation plan to reward exceptionally hard work, revolutionary ideas or designs that result in profit for the company. Such a plan recognizes people for isolated performances without promoting them to positions for which they might not be ready.
- Promotions accompanied by pay raises. A promotion without a raise is no promotion.

The accomplishment of a company's goals depends upon the smoothness and effectiveness of the interactions between its employees. The organizational structure, consisting of the company's purposes, goals and membership, primarily influences the quality and

A motivation checklist

When attempting to motivate a design-engineering staff, try taking the following actions:

- Don't criticize or otherwise squelch ideas with statements like, "It can't work" or "I've seen it before." You have a responsibility as an engineering manager to praise your designers' good ideas and offer constructive suggestions to those ideas that need improvement. You could greet each new idea with a positive comment, then point out areas you think need work, and end with another positive comment or encouragement.
- Give full credit to subordinates for constructive efforts and ideas, and tell your superiors about them.
- Be consistent. Inconsistent behavior lowers anyone's

morale and sense of personal security.

- Don't burden designers with administrative details; technical and administrative functions should remain separate.
- Design engineers often are isolated from the daily routine, assuming that whatever they put on paper will automatically work to perfection. Encourage them to come out of seclusion and interact with the rest of the engineering department to see how the people in the shops and test laboratories work on their creations. In other words, help foster a close relationship between the builders and the intellectual creators.
- Accompany departmental promotions with a company-

wide notice and possibly even an item in the local newspaper. Such action tremendously increases the morale of the person promoted and prevents any false rumors by keeping everyone fully informed about any departmental transitions.

- Above all, treat design engineers with the same respect you'd give any professional motivated by the principles of competence and integrity. Merely allowing this intrinsic motivation to blossom in a flexible organizational environment produces much more extensive long-term benefits than does any type of externally administered motivator.

Improve employee morale with strong leadership skills

frequency of these interactions. In an engineering department, individuals often work together temporarily on projects within an organization existing in constantly changing technological environments.

For these reasons, a flexible structure that only loosely defines organizational relationships, increases the natural flow of interactions among its members and fosters an atmosphere of trust and mutual support between managers and their staffs will best motivate an engineering department. Further, a company should encourage open communication, especially among designers within a department, because the strength of the engineering department depends upon close, integrated team play (Ref 4).

Leadership style, like organizational structure, varies from company to company. But regardless of the style, leaders must make decisions, right or wrong, without vacillating. A leader's indecisiveness lowers subordinates' confidence, and morale suffers.

By definition, design engineers must often work on their own; therefore, the most effective engineering managers give designers free rein in their creative functions. Achievement motivation (referring to McClelland's need theory) is a desirable trait in the engineering manager, and achievement-oriented leadership thus encourages achievement-oriented behavior

in designers. This type of leader sets challenging goals and expects subordinates to achieve them. Generally, the higher the achievement orientation of an engineering manager, the higher the confidence of the subordinates that their efforts will result in effective performance (Ref 3).

Allowing subordinates to participate in the decision-making process often improves morale, providing them with a greater sense of control on the job. Participative goal setting has been found to increase job satisfaction among engineers (Ref 1). And there are some other concrete actions a good leader can adopt to motivate a staff to do its best work (see box, "A motivation checklist").

Most engineering managers, especially at the first (supervisory) level, are competent engineers who have performed well at the bench and have thus been promoted to managerial positions. Suddenly, from a position that deals with objects, materials and designs (a job for which they are eminently well qualified), they enter a position that deals with people and administrative detail—something for which they have almost no experience or training. Yet they must somehow develop these managerial skills, and ideally, management will have the foresight to begin grooming them for the managerial task before their promotion. If you find yourself in such a position, remember that you possess the engineering competence to command the respect of your subordinates. Combining that competence with the motivational theories discussed in this article can improve your managerial ability.

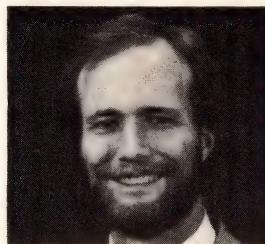
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Authors' biographies

Haluk Bekiroglu, professor and chairman of the Business Administration and Economics Dept at Eastern New Mexico University (Portales), earned his PhD in industrial engineering at Iowa State University in 1974. Before joining the ENMU faculty, he taught production-management and quantitative-methods courses at several other universities and provided consultation services for Gusdorf Corp. Author of more than 40 papers, Professor Bekiroglu is also a registered professional engineer and a member of AIDS, AIIE, SCS, TIMS, Tau Beta Pi, Sigma Xi and Beta Gamma Sigma.



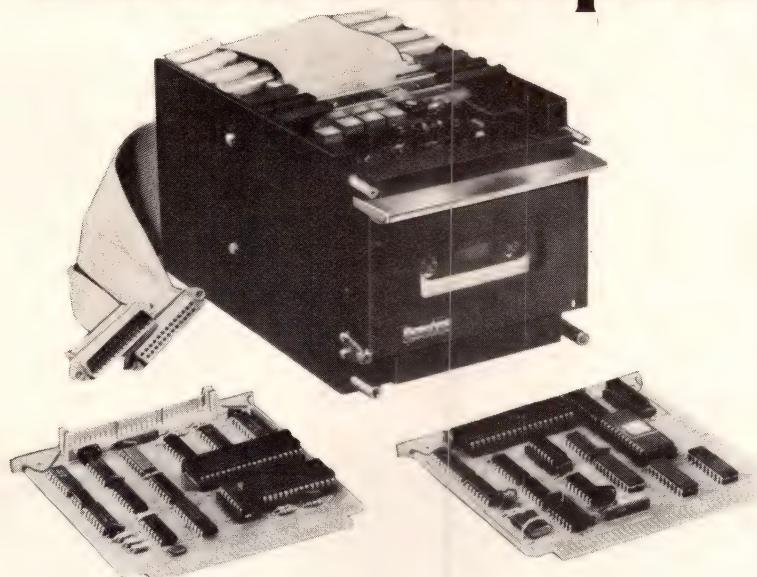
Carl Hutchison earned BS and MA degrees in psychology from Eastern New Mexico University. A teaching assistant in ENMU's College of Business while completing his MBA, he plays guitar, reads and enjoys the theatre in his leisure time.

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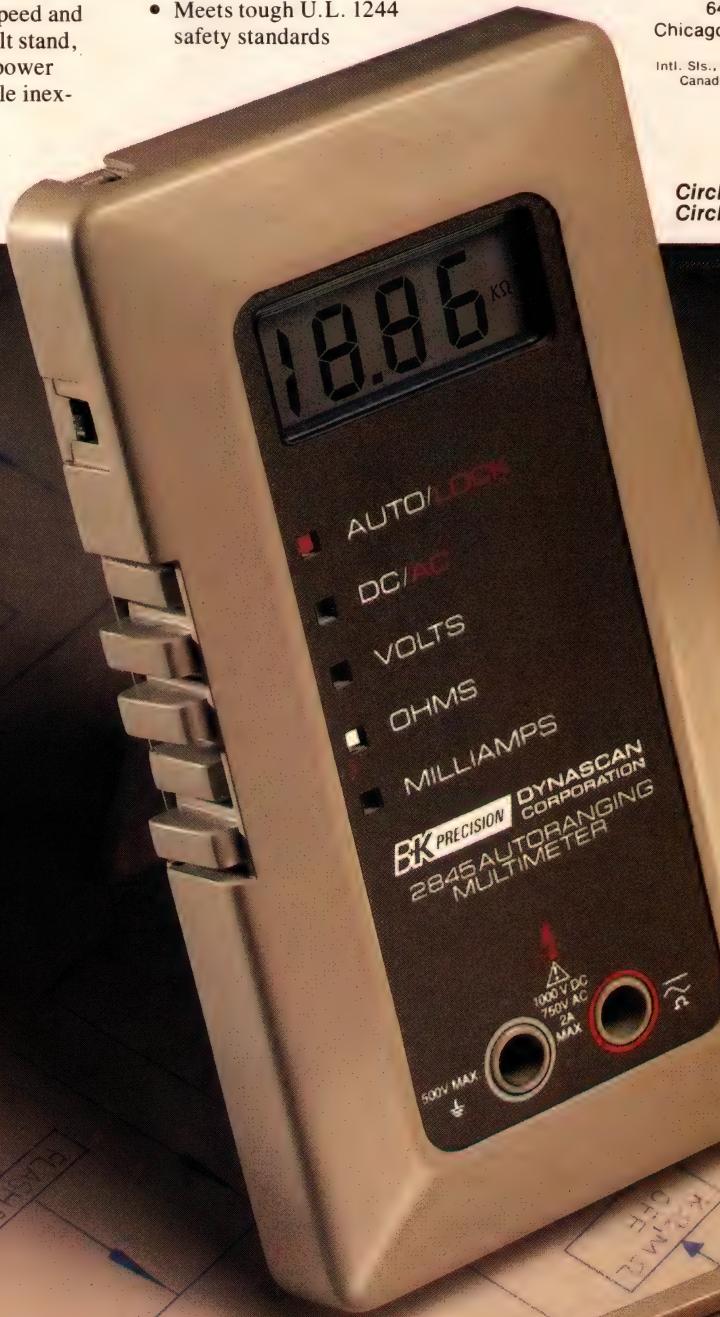
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Continuous autocal feature aids resistance measurement

You can easily implement a self-calibration pulsed-current technique that overcomes traditional resistance-measurement problems and permits 0.001-mΩ resolution to 2 mΩ FS.

Jules Schlesinger, UPA Technology Inc

When your DMM can't handle necessary low-value-resistance-measurement tasks, you can use off-the-shelf components to build a tester that does the job. The circuit presented here (Fig 1) permits 2-mΩ FS measurements to 0.001-mΩ resolution; you can select appropriate reference resistances to adapt this design to your range requirements.

The tester incorporates an autocalibration feature that provides two key advantages:

- Traditional methods depend on measurement of the voltage across the resistor under test (RUT), a voltage resulting from a supposedly known test current forced through the RUT. But note that the RUT can change the test current. Although the circuit presented here uses such voltage/current information, the autocal feature makes measurement accuracy independent of these test-current changes.
- The autocal feature also compensates for long-term drifts that contribute error in traditional measurement schemes. Production testers based on this technique exhibit less than ± 1 least-significant-digit (LSD) variation per day on the instrument's 3½-digit display.

Shunt provides reference

The heart of the circuit is an accurate reference resistance—a 1A, 1-mV shunt—connected in series with the RUT. (A $\pm 0.25\%$ shunt accuracy yields overall circuit accuracy of ± 1 LSD typ and ± 3 LSD max.)

Measurement values depend on the shunt and RUT voltages generated in response to 2-msec-wide test-current pulses spaced approximately 500 msec apart. In response to every second such pulse, the circuitry measures the shunt voltage to determine the test-current value; combining this current value with the RUT voltages measured on alternate test-current pulses yields the RUT resistance value.

The current value is determined by regulator chip

RG₁ and Q₇, Q₉ and R₄₆. Optocoupler U₁₀ controls the current-pulse timing (Fig 2) and isolates the test-current circuitry from the analog and digital grounds; to limit noise problems, tie these grounds together only at the power-supply transformer. A 4-terminal test fixture (with two current-injection nodes and two voltage-measurement points) applies the test current to the RUT.

CAL switches measurement from shunt to RUT

A calibration signal (labeled CAL in Fig 2) controls the alternate shunt/RUT voltage measurement; a sample/hold circuit consisting of A₁, C₄, Q₂ and A₂ samples the shunt or RUT voltage during the 2-msec test-current application and stores this information for the remainder of the 500-msec measurement cycle.

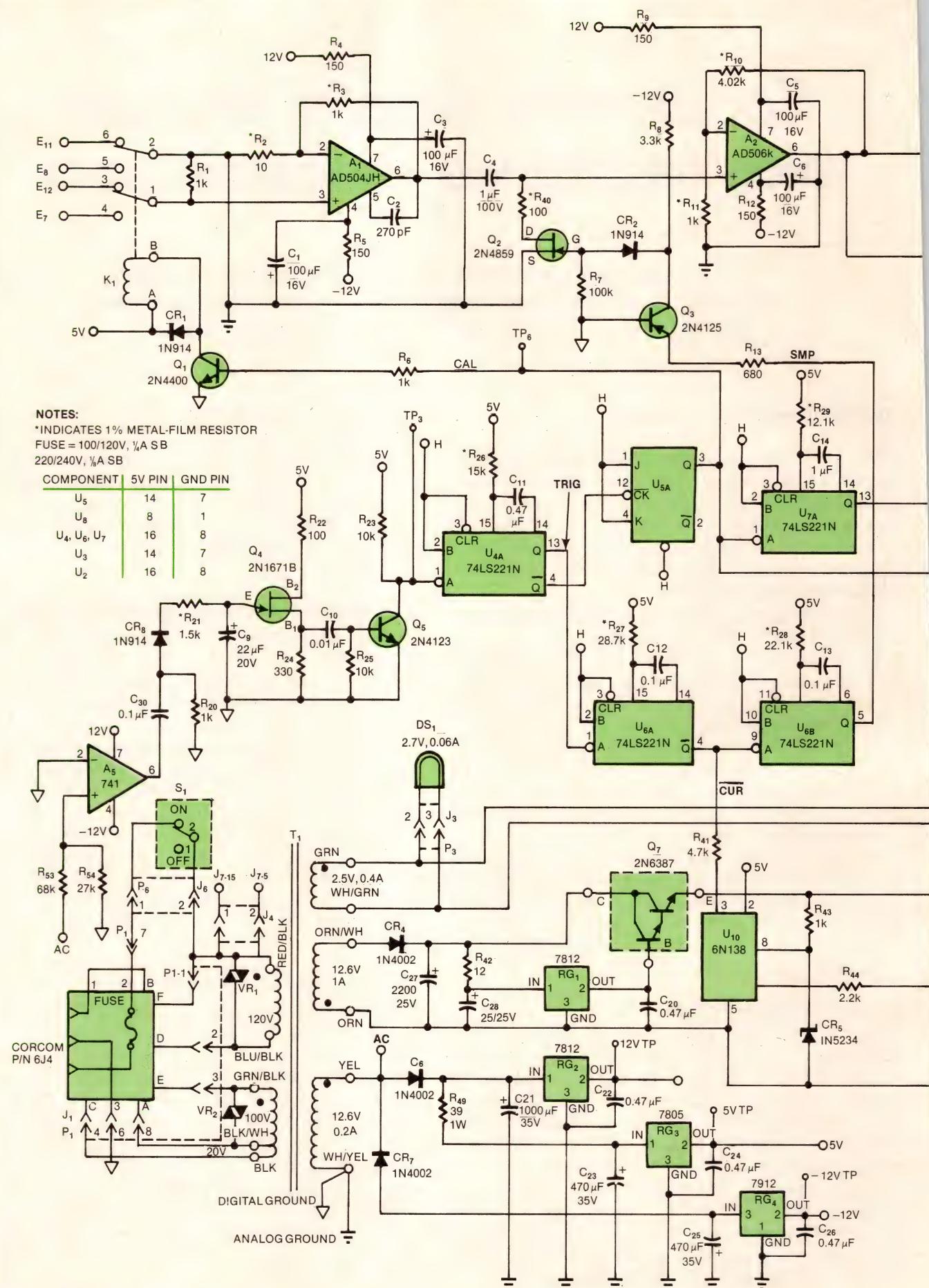
When CAL is HIGH, relay K₁ directs the shunt voltage to the sample/hold circuitry. Then an autogain configuration (U₁, A₃, U₉, U_{5B}, U_{3C} and U₂) adjusts the circuit's scale factor in response to the test current's measured value. This adjustment technique uses multiplying D/A converter U₁'s variable-resistance parameter. The DAC's variable-resistance function controls amplifier A₃'s gain by paralleling A₃ input resistor R₁₄.

DAC determines amplifier gain

To determine the correct A₃ gain, the shunt voltage measured during the calibration period—which corresponds to a 1-mΩ resistance level—feeds to the DAC input (pin 15). Oscillator U₈ then increments counter U₂ (which is reset before each self-calibration cycle) via gate U_{3C}. The counter in turn steps the DAC, thus decreasing the DAC's equivalent resistance until comparator U₉ determines that amplifier A₃'s output equals the voltage corresponding to 1 mΩ. (You can adjust this voltage via potentiometer R₃₈, which serves as the system calibration adjustment.) Transistor Q₁₂ and gates U_{3A} and U_{3B} blank the display during autocalibration cycles.

When comparator U₉ detects that the system gain is

Text continues on pg 128



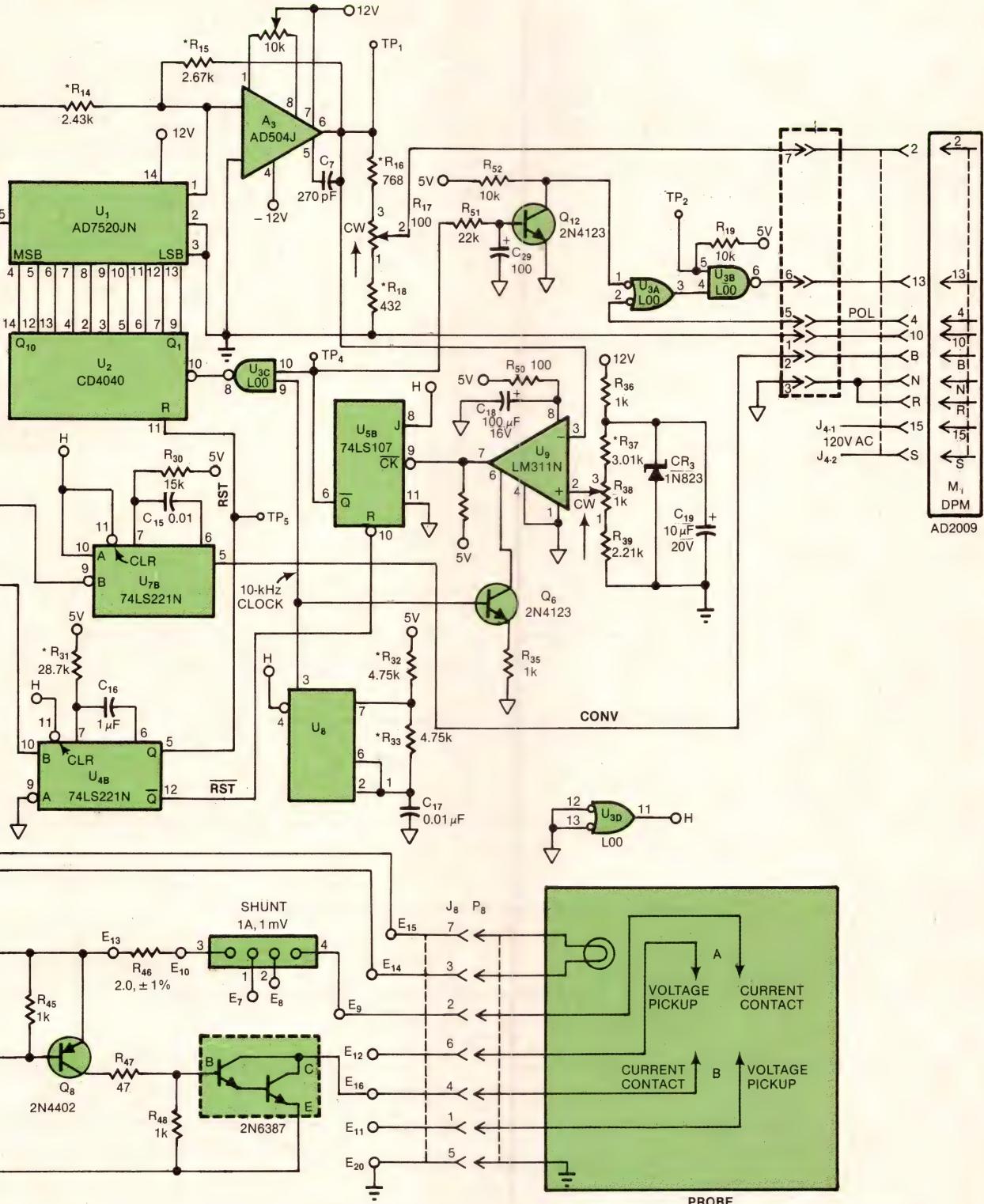


Fig 1—Off-the-shelf components can implement a self-calibrating resistance-measurement system. Note the separate analog and digital grounds. Although production testers based on this circuit utilize single pc boards, separate ground buses for each signal type improve stability; ground instabilities might otherwise cause the display's least significant digit to flicker. Tie

these grounds together at the power-supply transformer, then connect this junction to the input-power connector (Corcom P/N 6J4) and thus to the instrument chassis. If you don't follow such grounding procedures, you could spend more time looking for proper ground points than you do debugging all other problems.

Self calibration enhances stability

correct, it shuts off gate U_{3C} to prevent further changes in the DAC's output resistance. On the next measurement cycle, CAL switches LOW, causing relay K_1 to apply the RUT voltage to the sample/hold circuitry. The resulting voltage at A_3 's output then connects to a DPM via pot R_{17} , which adapts A_3 's full-scale output to the full-scale level the DPM requires.

Timing components control measurement periods

Proper timing for these measurement cycles involves the operation of A_5 , Q_4 , Q_5 , U_{4A} , U_{5A} , U_{6A} , U_{6B} , U_{7A} , U_{7B} and U_{4B} . These components constitute the system's sequencer/controller.

The first step in timing control is generation of a signal that defines the 500-msec measurement periods; amplifier A_5 and transistors Q_4 and Q_5 accomplish this function. Furthermore, A_5 monitors the ac line and locks the measurement cycles to the line to reduce 60-Hz-hum effects.

The output of the A_5 , Q_4 , Q_5 combination drives

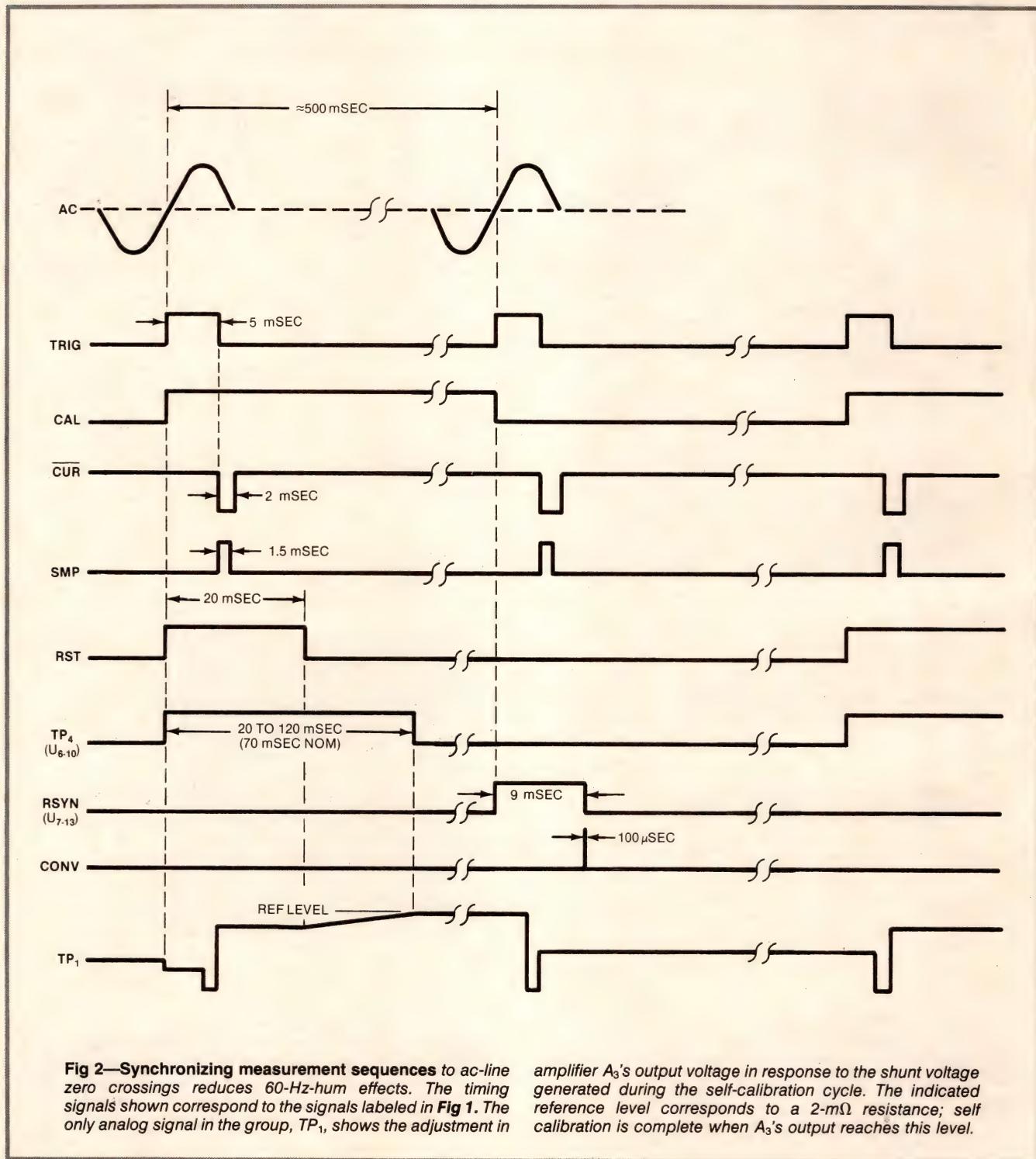


Fig 2—Synchronizing measurement sequences to ac-line zero crossings reduces 60-Hz-hum effects. The timing signals shown correspond to the signals labeled in Fig 1. The only analog signal in the group, TP₁, shows the adjustment in

amplifier A_3 's output voltage in response to the shunt voltage generated during the self-calibration cycle. The indicated reference level corresponds to a 2-mΩ resistance; self calibration is complete when A_3 's output reaches this level.

one-shot U_{4A}, which in turn generates a 5-msec-wide TRIG pulse. This signal drives toggle flip flop U_{5A}, in turn driving Q₁ and causing relay K₁ to alternately switch the reference and measurement voltages to sample/hold capacitor C₄.

One-shot U_{6A} furnishes a CUR pulse, which controls the test current. U_{6B} generates a signal (SMP) that controls the sample/hold circuitry. U_{7B}'s output (CONV) signals the DPM to begin voltage conversion.

Testers based on this design technique have achieved full-scale ranges to 200 mΩ. You can adapt the technique to even higher ranges depending on your ability to control the smaller test currents required for the larger reference and RUT resistances. **EDN**

Author's biography

Jules Schlesinger, chief engineer at UPA Technology Inc, Syosset, NY, designs instruments for nondestructive test using resistive, eddy-current and beta-backscatter techniques. Before serving 7 yrs at UPA Technology, he worked at Eaton's AIL Div for 14 yrs. Jules earned a BEE and MEE at the City College of New York and has served as an adjunct professor there. He holds two patents and is a member of the IEEE.



Acknowledgment

The author thanks Barry Rutkin, former UPA Technology engineer, for design and development help.

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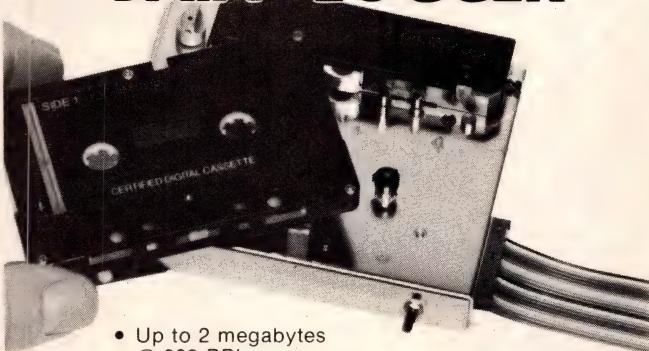
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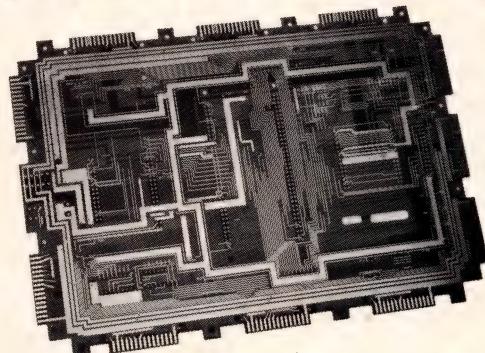
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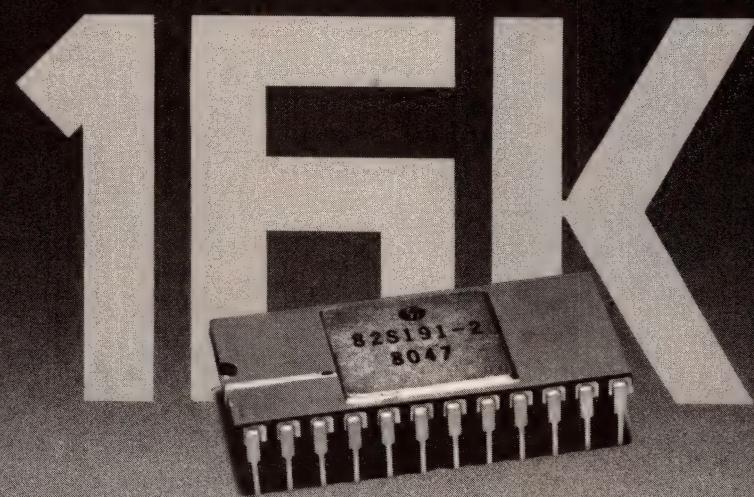
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Memory-error program evaluates reliability tradeoffs

RAM-error-correction procedures provide benefits—and entail problems—that depend on memory organization, failure rate and maintenance. A computer program tells you how these factors influence system reliability.

Steven Grossman and Fred Jones, Mostek Corp

Using the computer program presented in this 2-part series, you can explore the system-reliability effects of incorporating single-bit-error correction in RAM arrays.

Small arrays with long mean time to error (MTTE) usually don't incorporate error correction because it contributes little to—and sometimes even reduces—reliability, despite its high cost and complexity. But larger systems with short MTTE profit significantly when error correction combines with periodic hard- and soft-error maintenance.

The Microsoft BASIC computer program described here implements a probabilistic memory-reliability model; it calculates the probability of and mean time to double-bit hard or soft errors in any word of a $\times 1$ -bit-RAM array. This first part of the series explains the underlying assumptions and concepts involved in deriving the program. To demonstrate practicality, a sample program run computes a typical memory system's reliability. Part 2 will detail the impact of varying system parameters on reliability.

Start with basic error definitions

Study of a memory system's reliability must begin at the component level. Obviously, reliable memory systems require devices with low failure rates, although even highly reliable devices fail eventually because of internal physical changes (hard-error mechanisms).

Such hard errors become obvious when a memory device yields erroneous data and a rewrite operation doesn't correct the error. The exact number of failed locations associated with a single failure or hard error depends mostly on the failure mechanism and the device's internal organization.

Accordingly, the average percentage of a device lost

because of a hard error is an input parameter important to the reliability model presented here. In practice, the distribution of device failures isn't constant; the failure rate generally decreases with time, assuming the absence of RAM wearout mechanisms associated with end of life.

In addition to hard errors, the reliability model also considers soft ones such as those produced by alpha-particle radiation. Because soft errors aren't catastrophic, you can correct them by rewriting the error location. And note that alpha-particle radiation generally affects only one location in a storage device; that location then has the same probability of encountering another soft error as any other location in the device.

Unlike hard errors, most soft errors occur at a rate that remains constant over long periods of time. But while alpha-type error rates don't vary with time, they do change as a function of the device's access rate.

Additionally, soft errors resulting from noisy system environments or vendor-specification violations often remain unpredictable and affect more than one storage location. Thus, the reliability model doesn't include this soft-error type because you can avoid it with careful design.

By using redundant parity check bits, you can readily detect and correct hard and soft errors in memory arrays. Hamming or other single-error-correcting codes (EDN, May 20, 1980, pg 153) find widespread use in RAM systems to correct single-bit errors within a fetched word. Even with single-error-correction capability, though, multiple-bit errors within the same accessed word go uncorrected and can cause system failures. But because multiple-bit-error correction is rarely used, the reliability model focuses on single-bit-error correction. With appropriate system maintenance, single-bit correction generally ensures acceptable reliability.

System reliability model handles hard and soft errors

Maintenance techniques aid system reliability

The model considers both hardware and software maintenance techniques:

- *Soft-error scrub*—a software or hardware method—purges correctable soft errors from the memory system.
- *Hard-error maintenance*—a hardware service—replaces failed devices—(hard errors only) in the memory system.
- *Memory deallocation*—a software technique for use only with mapped memory systems—

removes memory blocks containing hard errors from available system memory; data within these blocks is relocated, and the blocks are deallocated from the available memory's page pool. Each time the deallocation process occurs, however, the total amount of available system memory decreases.

Reliability model aims at memory array

To enhance flexibility, the reliability model allows you to specify individual maintenance parameters such as block size for memory deallocation and time intervals between applied maintenance techniques. And to avoid complexity, the model doesn't consider memory-system support circuits. Instead, it focuses on the system's storage portion to accurately calculate the occurrence

```
50 REM PROGRAM TO CALCULATE PROBABILITY OF AND MEAN TIME TO SECOND
60 REM HARD OR SOFT ERROR IN ANY WORD OF A COMPUTER MEMORY SUBSYSTEM
70 REM ** COPYRIGHT STEVEN GROSSMAN/FRED JONES, MOSTEK CORPORATION 1980 **

100 PRINT CHR$(12): REM CLEAR SCREEN
110 FLAG=0
115 REM INITIALIZE SYSTEM PARAMETERS
120 P=.10
130 RD=1E8
140 REP=1E8
150 K=2048: DA=1E8
160 INPUT "BITS PER WORD";BW: IF FLAG=1 THEN 440
170 INPUT "WORDS PER SYSTEM (K)";W: W=W*1024: IF FLAG=1 THEN 440
180 INPUT "DEVICE SIZE (K BITS)";N: N=N*1024: IF FLAG=1 THEN 440
190 INPUT "SOFT ERROR RATE (%/1K HRS.)";ES: IF FLAG=1 THEN 440
200 INPUT "HARD FAILURE RATE (A,B,C IN A(T^B-(T-1)^B)+C % IN T' TH IK HR. PERIOD)
;"A,B,C
210 IF FLAG=1 THEN 440

220 PRINT CHR$(12)
230 PRINT "*****"
240 PRINT "PARAMETRIC SUMMARY TABLE": PRINT
250 PRINT TAB(11),"SYSTEM CONFIGURATION"
260 PRINT " 1 BITS PER WORD = ";BW
270 PRINT " 2 WORDS PER SYSTEM = ";W/1024;"K"
280 PRINT " 3 DEVICE SIZE = ";N/1024;"K BITS"
290 PRINT: PRINT TAB(11);"ERROR RATES"
300 PRINT " 4 SOFT ERROR RATE = ",ES,"%/1K HOURS"
310 PRINT " 5 HARD FAILURE RATE = (";A;"("T ^";B;" - (T-1) ^";B;) +";C;") % IN T' TH IK HOURS"
320 PRINT " 6 PERCENT OF DEVICE LOST DUE TO HARD FAILURE = ";P*100;"%"
330 PRINT:PRINT TAB(11);"MAINTENANCE PARAMETERS"
340 PRINT " 7 SOFT ERROR SCRUB INTERVAL = ";RD;"DAYS"
350 PRINT " 8 FAILED MEMORY REPLACEMENT INTERVAL = ";REP;"DAYS"
360 PRINT " 9 MEMORY DEALLOCATION = ";K/1024;"K WORDS PER HARD FAILURE EVERY D DAYS"
370 PRINT: PRINT "*****"
380 PRINT INPUT "IS A CHANGE TO THE PARAMETRIC SUMMARY TABLE REQUIRED";TC$ 
450 IF LEFT$(TC$,1)="N" THEN 500
460 PRINT: INPUT "WHAT IS LINE NUMBER OF PARAMETER TO BE CHANGED";PN
470 FLAG=1
480 IF PN=0 OR PN<1 THEN 460
490 ON FN GOT0 160,170,180,190,200,530,550,570,590
500 INPUT "DO YOU WANT AN UPDATED SUMMARY TABLE";STS
510 IF LEFT$(STS,1)="Y" THEN 220
520 GOTO 615
530 INPUT "PERCENT OF DEVICE LOST DUE TO HARD FAILURE";P: P=P/100
540 GOTO 440
550 INPUT "SOFT ERROR SCRUB INTERVAL (DAYS)";RD: RD=RD/10
560 GOTO 440
570 INPUT "FAILED MEMORY REPLACEMENT INTERVAL (DAYS)";REP
580 REP=REP/10: GOTO 440
590 INPUT "MEMORY DEALLOCATION (K WORDS PER HARD FAILURE EVERY D DAYS)";K,DA
600 K=K*1024: DA=DA/10
610 GOTO 440
615 TS=1E12: IF ES<0 THEN 690
620 TS=(100000/240)*#/(ES*BW*W) :REM TIME TO SOFT HIT
630 PRINT: PRINT "*****": PRINT "HEADINGS"
640 PRINT "EXISTING", "EXISTING", "ALLOCATED", "DAY", "DOUBLE"
650 PRINT "HARD HITS", "SOFT HITS", "GOOD WORDS", "ELAPSED", "HIT PROB."
660 PRINT
670 PRINT: PRINT "*****"
675 LDH=.999 :REM USED FOR DETERMINING WHEN TO PRINT VALUES
680 SWFAIL=0:HWF fail=0 :REM BAD WORDS DUE TO SOFT AND HARD ERRORS
690 SPROB=1:HPROB=1:PROB=1 :REM 1 - DBL BIT HIT PROB. DUE TO SOFT,
700 GRD=RD: S=0 :REM HARD, AND ALL ERRORS RESPECTIVELY
710 HDA=DA: ALL=W: HID=0
725 IF K<0 THEN HDA=1E12
730 REM SET TIMES TO SOFT AND INITIAL HARD HIT
740 SOFT=TS
750 IF (A=0 OR B=0) AND C=0 THEN HARD=1E12 ELSE HARD=100*N/((A*(.24*B)+.24*C)*BW
    *W)
755 IF K<0 THEN HDA=1E12

787 REM SET TIMES TO SOFT AND INITIAL HARD HIT
790 SOFT=TS
795 IF (A=0 OR B=0) AND C=0 THEN HARD=1E12 ELSE HARD=100*N/((A*(.24*B)+.24*C)*BW
    *W)

800 REM NOW ITERATE AT 10 DAY INTERVALS
810 FOR T=1 TO 2000 :REM UP TO 20,000 DAYS OR 55 YEARS
820 SRD=GRD-1: HREP=HREP-1: HDA=HDA-1
830 REM COUNT DOWN ITERATIONS TO MAINTENANCE

840 IF SRD>0 THEN 900: REM SCRUB SOFT ERRORS
850 SPROB=1
860 HPROB=HPROB
870 SWFAIL=0: S=0
880 HID=SRD+RD
890 IF SRD<0 THEN 880

900 IF HREP>0 THEN 970: REM REPLACE FAILED DEVICES
910 HPROB=1
920 HREP=SPROB
930 HWFAIL=0: HID=0
940 ALL=W
950 HREP=HREP+REP
960 IF HREP<0 THEN 950

970 IF HDA >0 THEN 1050: REM DEALLOCATE FAILED MEMORY
980 HPROB=1
982 DH=HID*# :REM DEALLOCATED WORDS
985 IF HID>0 THEN PROB=1 ELSE 1030
990 HWFAIL=HWFAIL-DH
1000 SI=S*(ALL+HWFAIL)/ALL :REM TO COMPENSATE FOR DEALLOCATED SOFT ERRORS
1005 IF HWFAIL<0 THEN HWFAIL=0
1010 ALL=ALL-DH :REM "ALL" IS ALLOCATED WORDS IN SYSTEM
1012 IF SI<1 THEN 1028
1015 FOR J=1 TO SI-1
1020 PROB=PROB*(ALL-J)/(ALL-J/BW) :REM RECALCULATE PROB. BASED ON JUST SOFT E
RRORS
1025 NEXT J
1028 HID=0
1030 HDA=HDA+DA
1040 IF HDA<0 THEN 1030

1050 SOFT=SOFT-1: HARD=HARD-1
1060 REM COUNT DOWN ITERATIONS TO A HIT

1070 IF SOFT>0 THEN 1150: REM PROCESS SOFT ERROR
1080 SPROB=SPROB*(W-S)/(W-S/BW) :REM PROB. DUE TO SOFT ERRORS ONLY
1090 BADW=SWFAIL+HWFAIL
1100 PROB=PROB*(ALL-BADW)/(ALL-BADW/BW) :REM PROB. DUE TO ALL ERRORS
1110 SWFAIL=SWFAIL+1
1120 S=S+1
1130 SOFT=SOFT+TS
1140 GOTO 1070

1150 IF HARD>0 THEN 1220: REM PROCESS HARD ERROR
1160 BH=HID*(PN*2-1): IF BH>HID*N THEN BH=HID*N: IF BH<0 THEN BH=0
1170 BADW=S*PN+BH
1180 HPROB=HPROB*(ALL-BH)/(ALL-BH/BW) :REM PROB. DUE TO HARD ERRORS ONLY
1190 PROB=PROB*(ALL-BADW)/(ALL-BADW/BW) :REM PROB. DUE TO ALL ERRORS
1193 HWFAIL=HWFAIL+PN
1196 HID=HID+1
1200 HARD=HARD+100*N/((A*((.24*(T+1))^B-(.24*T)^B)+(24*C))*BW*W)
1205 REM RECALCULATE TIME TO NEXT HIT BASED ON WEIBULL DIST. PARAMETERS
1210 GOTO 1150

1215 REM PRINT RESULTS AT INCREMENTS OF PROBABILITY SET BY "LN" BELOW
1220 IF PROB>LN THEN 1250
1230 IF LN=.951 THEN LN=LN-.001 ELSE LN=LN+.05
1235 IF PROB<LN THEN 1230
1240 PRINT HID,S,ALL-(SWFAIL+HWFAIL),T*10,1-PROB
1245 IF LN=.45 THEN 1260
1250 NEXT T

1255 REM RESTART PROGRAM IF DESIRED
1260 PRINT: INPUT "DO YOU WISH TO RETURN TO THE PARAMETRIC SUMMARY TABLE";TS
1270 IF LEFT$(TS,1)="Y" THEN 220
1280 PRINT: INPUT "DO YOU WISH TO RESTART PROGRAM?";TS
1290 IF LEFT$(TS,1)="Y" THEN 100
1300 STOP
1310 END
```

Fig 1—Written in Microsoft BASIC, this computer program calculates the probability of and the mean time to double-bit hard or soft errors in any word of a \times 1-bit RAM array.

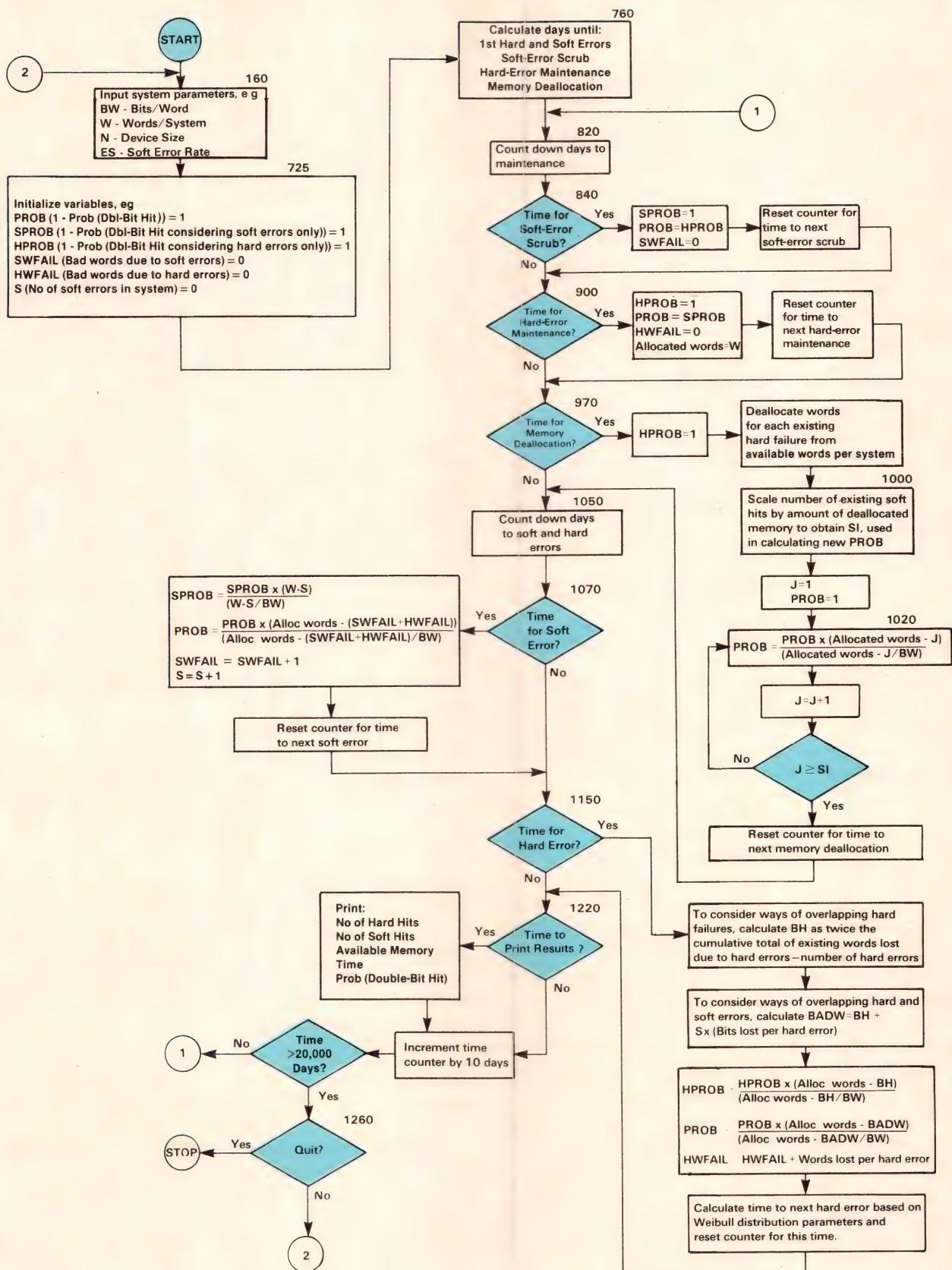


Fig 2—A flowchart represents the implementation of the memory-system reliability model. Statement numbers outside certain boxes provide correlation with Fig 1's program.

Hardware and software maintenance improve system reliability

probability of uncorrectable combinations of hard and/or soft errors in a single-error-correcting system. You can then combine this memory-array failure probability with the support circuits' failure probability to establish the memory system's overall reliability.

Because support circuits vary in complexity depending on the application, a generalized support-circuit reliability model is difficult to construct. Support-circuit reliability can be easier to calculate than memory-array reliability, though, because a single error within the support circuits generally causes a system failure.

MTTE predicts error occurrences

Before analyzing a memory array's reliability when it's provided with error-correction capabilities, determine the array's reliability without error correction. You can easily perform this task by computing the array's MTTE as a function of the component error rates. Specifically,

$$\begin{aligned} \text{MTTE} &= \frac{1}{(\text{error rate per device})(\text{devices per system})} \\ &= \frac{1}{(\text{error rate per device})(\text{bits per device})} \\ &= \frac{1}{(\text{error rate per device})(\text{bits per word})(\text{words per system})}. \end{aligned}$$

As an example of such a calculation, consider a 256k×16-bit memory system composed of 16k×1-bit dynamic RAMs. Assume that the system's overall component error rate equals 0.1% per 1000 hrs (one error per 1,000,000 device-hrs). Therefore,

$$\begin{aligned} \text{MTTE} &= \frac{16k}{(0.001/1000)(16)(256k)} \\ &= 3906.25 \text{ hrs} = 162.76 \text{ days}. \end{aligned}$$

Thus, a 50% chance exists that an error will occur within 163 days of operation. If this memory system has single-error-correction capability, though, an error in one storage device should not cause a system failure. Only two or more errors in the same word would affect system reliability.

Error correction also has an interesting effect on the mean time between device errors (hits). If you add six bits to each 16-bit word to obtain single-error-correction and double-error-detection capabilities, for instance, the system's MTTE with 22-bit words drops from 163 to 118 days. Why? Because device errors occur more frequently when you increase the number of memory components. On the other hand, the system reliability model demonstrates that error correction can dramatically improve overall reliability.

Double-bit-hit probability forms model core

System reliability with error correction relies heavily on the occurrence probability of two or more errors in the same memory word. The probability

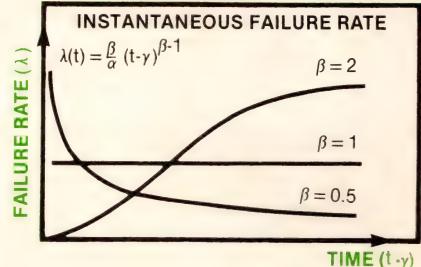


Fig 3—The extremely flexible Weibull distribution adapts readily to RAMs' infant-mortality and random-failure characteristics associated with the classic bathtub-shaped life distribution curve. α represents a scale factor, β a shape parameter and γ a time-delay parameter. Based on historical failure data, NMOS RAMs' β typically equals 0.5, γ is zero and α is related to device reliability.

calculation for finding two or more persons with the same birthday in a group closely resembles this double-error probability calculation. In the birthday example, the first person considered has 365 out of 365 days on which to have a birthday without causing an overlap of dates; the second person's birthday can occur on only 364 out of 365 days without causing an overlap with the first person's. Similarly, the third person's birthday can occur on one of 363 out of 365 days, and so on.

Hence, the probability of no overlap of birthdays among three persons is

$$(365/365) \times (364/365) \times (363/365) = 0.99.$$

You can calculate the probability of an overlap of birthdays (P) among a group of N persons as follows:

$$P = 1 - \prod_{i=0}^{N-1} \frac{365 - i}{365}.$$

You can extrapolate this equation to one for memory-system reliability by substituting "words per system" for "days per year" and "loss of some number of words per error" for "loss of one available birthday per year for each person in the group." Then, for the basic memory reliability model, the probability of double-bit hits (P_D) is:

$$P_D = 1 - \prod_{i=1}^{\text{NO OF HITS}} \frac{\text{error-free words after hit } i}{(\text{words per system}) - \left(\frac{\text{bad words after hit } i}{\text{bits per word}} \right)}.$$

Although this equation refers to a double-bit-hit probability, it also includes the smaller probability of more than two hits occurring in the same memory word. In most cases, though, by the time the probability of three or more hits becomes significant, the memory system has become highly prone to double-bit hits.

Note that you subtract the second term in the denominator from "words per system" to compensate for the fact that two hits in one memory bit in a word don't create a system failure. That is, if you assign 22

bits per word and an error exists in a word, then on average, one of the 22 additional errors that might occur in this word takes place in this same bit position. But such an occurrence doesn't act as a double-bit error.

This basic double-bit-hit approach provides the nucleus of the reliability-model program. **Fig 1** lists the program, and **Fig 2** presents a flowchart describing its operation.

Reliability model works with $\times 1$ devices

In addition to considering accumulated error effects,

the program can examine the effects of the various maintenance techniques that remove memory-system errors. If you want to model the memory-deallocation technique, though, specify at least as many words to be deallocated per hard error (the block size) as are affected by the error. Otherwise, a complete deallocation won't occur.

Because maintenance is periodic, the program iterates over time rather than over the number of hits. Even so, the program can model nonperiodic hard-error occurrences with a Weibull distribution (**Fig 3**). Using this approach, you provide parameters for A, B

```
BITS PER WORD? 22
WORDS PER SYSTEM (K)? 256
DEVICE SIZE (K BITS)? 16
SOFT ERROR RATE (%/1K HRS.)? .1
HARD FAILURE RATE (A,B,C IN A(T^B-(T-1)^B)+C % IN T' TH 1K HR. PERIOD)? .05,1,0
*****
```

PARAMETRIC SUMMARY TABLE

SYSTEM CONFIGURATION

```
1 BITS PER WORD = 22
2 WORDS PER SYSTEM = 256 K
3 DEVICE SIZE = 16 K BITS
```

ERROR RATES

```
4 SOFT ERROR RATE = .1 %/1K HOURS
5 HARD FAILURE RATE = (.05 (T ^ 1 - (T-1) ^ 1 ) + 0 ) % IN T' TH 1K HOURS
6 PERCENT OF DEVICE LOST DUE TO HARD FAILURE = 10 %
```

MAINTENANCE PARAMETERS

```
7 SOFT ERROR SCRUB INTERVAL = 1E+09 DAYS
8 FAILED MEMORY REPLACEMENT INTERVAL = 1E+09 DAYS
9 MEMORY DEALLOCATION = 2 K WORDS PER HARD FAILURE EVERY 1E+09 DAYS
*****
```

IS A CHANGE TO THE PARAMETRIC SUMMARY TABLE REQUIRED? NO
DO YOU WANT AN UPDATED SUMMARY TABLE? NO

EXISTING HARD HITS	EXISTING SOFT HITS	ALLOCATED GOOD WORDS	DAYS ELAPSED	DOUBLE HIT PROB.
1	2	260504	240	.0119421
1	3	260503	360	.0178457
2	4	258863	480	.0587201
3	6	257223	720	.136062
3	7	257222	830	.151557
4	8	255582	950	.236639
4	9	255581	1070	.254898
5	10	253942	1190	.351214
6	12	252302	1430	.470072
7	14	250661	1660	.584401

DO YOU WISH TO RETURN TO THE PARAMETRIC SUMMARY TABLE? NO

DO YOU WISH TO RESTART PROGRAM? NO

Fig 4—A sample run of the reliability program presents reliability characteristics for the reference memory system described in the table. By plugging in the system's key parameter values, you get a parametric summary table and a listing of applicable hard- and soft-error information.

Double-bit-hit scheme serves as the reliability program's basis

and C in the following equation:

$$\text{failure rate} = A(t^B - (t - 1)^B) + C.$$

This equation defines a failure rate between the $(t-1)$ th and the (t) th 1000-hr period. This rate equals the integral of the Weibull distribution presented in Fig 3, in which α equals $100/A$ (with A a percentage) and β equals B. Assume that the γ term is zero. The C enters a constant offset to the Weibull distribution's failure rate.

Consider further the reliability program's modeling of hard and soft errors. One constant error rate models the soft-error occurrences. Even though the program also uses one hard-error rate to model hard-error occurrences, this rate's meaning is considerably more complicated than that for soft errors. This complication arises because some memory devices, such as dynamic RAMs, are characterized by a variety of hard-failure mechanisms that can affect single bits, rows, columns or larger device portions. Rather than consider a separate rate for each failure mechanism, the program models the hard-failure modes using one failure distribution and an additional parameter associated with the average percentage of device lost due to a hard error.

To elaborate, the percentage of device lost depends on the failure frequencies of the different hard-failure mechanisms and on other orthogonality considerations. (Because one hard error in a memory array utilizing single-chip-wide-word RAMs can affect several bits in one word, you can apply this model only to systems composed of $\times 1$ devices.) With $16k \times 1$ dynamic RAMs (internally arranged in a 128×128 matrix) in a 16k-word system, for instance, an internal row failure in one RAM and a column failure in another almost certainly cause a double-bit hit, even though each hard error affects only 128 out of 16,384 bits.

If, for example, out of all hard errors, 20% are column failures, 10% are row failures and 8% are entire-RAM failures, you can compensate for orthogonality factors by considering 2% ($20\% \times 10\%$) of the 128-bit row and column failures to be entire-RAM failures. In other words, to calculate the average percentage of device lost, consider 10% (8% entire-RAM failures + 2% orthogonality adjustment) as affecting the entire device and 28% (20% column failures + 10% row failures - 2% orthogonality adjustment) as affecting only 128 bits.

The weighted average of these values and those associated with single-bit and other hard-error types helps determine the percentage used in the program. The model thus does not lose significant precision as a result of substituting one hard-error rate and one percentage for multiple hard-failure mechanisms.

Furthermore, the model makes a conservative but

REFERENCE-MEMORY-SYSTEM PARAMETERS

SYSTEM CONFIGURATION

- WORD SIZE: 22 BITS
- SYSTEM SIZE: 256K WORDS
- DEVICE SIZE: 16k \times 1-BIT RAMs

ERROR RATES*

- SOFT-ERROR RATE: 0.1%/1000 HRS
- HARD-FAILURE RATE: 0.05%/1000 HRS (CONSTANT)
- PERCENT OF DEVICE LOST DUE TO HARD FAILURE: 10%

MAINTENANCE PARAMETERS

- SOFT-ERROR SCRUB: NONE
- HARD-ERROR MAINTENANCE: NONE
- MEMORY DEALLOCATION: NONE

* CONSERVATIVE INDUSTRY FIGURES

realistic assumption that soft errors and hard failures distribute uniformly throughout the memory system. To correctly model hard errors that affect more than one bit, the program must calculate the number of ways such a multiple-bit error can overlap all other existing errors in the system. If a hard error causes n bits to fail, for instance, areas of n bits around each soft error in the system and $2n-1$ bits around each n-bit hard error could overlap the new hard error. What's more, if the hard and soft errors lie tightly spaced, so that these overlap areas themselves overlap and are hence partially counted twice in the model, the program slightly overstates the probability of a double-bit hit. This situation usually occurs only when the memory already contains so many errors that the system becomes significantly prone to double-bit hits.

You can change memory-system parameters

Although the flowchart shown in Fig 2 doesn't illustrate the input procedure in detail, the program contains an input facility that allows you to view the system parameters in a menu format and easily change them. Because the program's output facility isn't as sophisticated, you can change program statements 1220 through 1245 to print the double-bit-hit probability at desired time intervals.

You can also add a facility to graph the results (Part 2 will show results in that form). However, you must smooth the curves because the probability values generated by the model increase only when errors occur and thus don't follow a smooth curve. Note, however, that periodic soft- and hard-error-maintenance techniques correctly cause discontinuities in the probability curve.

Consider a reliability example

As an example of the reliability model's results, consider the reference memory system defined in the table. This system is a typical medium-sized array with error-correction and -detection capabilities. Its 22-bit words allow 16 data bits and six check bits for single-error correction and double-error detection. The system's 256k-word size provides storage for 512k data bytes.

The 16k \times 1 dynamic RAMs that compose the array exhibit a soft error rate of 0.1% per 1000 hrs of operation. A constant hard error rate of 0.05% per 1000 hrs is assumed for simplicity, although a Weibull distribution with a higher early-life failure rate might be more realistic. Employing the calculations described earlier, the weighted average percentage of device lost per hard error is assumed to be 10%. The error rates and percentage presented represent conservative industry figures for 16k RAMs.

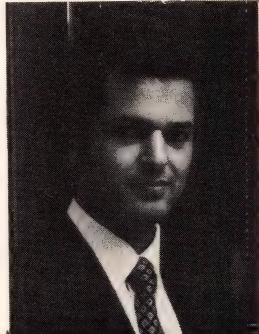
For insight into other system parameters' effects, assume that the reference memory system receives neither a soft-error scrub nor hard-error maintenance. Fig 4 presents a sample run of the reliability program for this system. Part 2 will examine the effects of varying the system's configuration, error rates and maintenance parameters. **EDN**

Reference

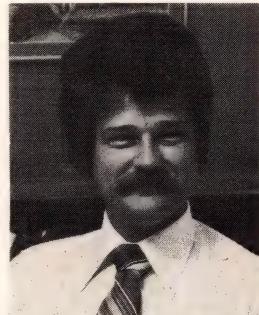
Accelerated Testing Handbook, Technology Associates and Bell Telephone Laboratories, 1978.

Authors' biographies

Steven Grossman, a memory-product-line manager at Mostek Corp, Carrollton, TX, handles strategic marketing and financial planning for new devices. Holder of an MBA from the Wharton School of the University of Pennsylvania and a BS in computer science and engineering from the Massachusetts Institute of Technology, he previously worked at International Data Base Systems. Steve maintains membership in Tau Beta Pi and Eta Kappa Nu.



Fred Jones is Mostek's applications-support manager for dynamic, pseudostatic and high-speed \times 1 static RAMs. He joined the firm after working for Modular Computer Systems and Motorola Communications Inc. Holder of a BSEE from the University of Florida, Fred belongs to Tau Beta Pi, Eta Kappa Nu and Phi Kappa Phi.



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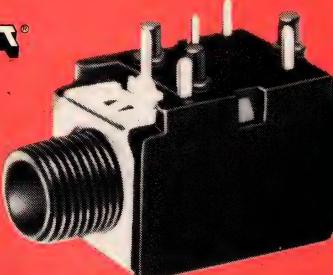
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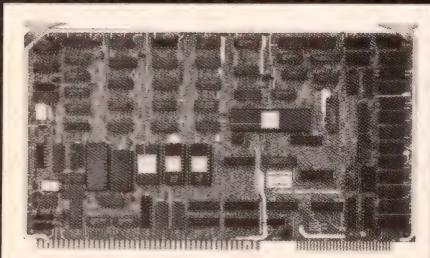
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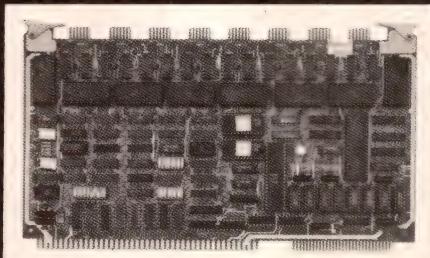
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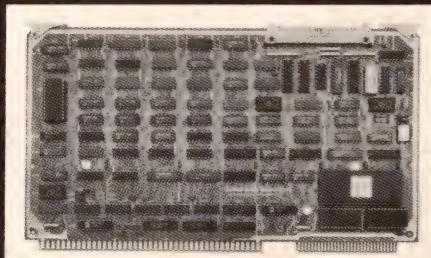
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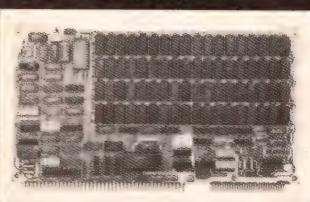
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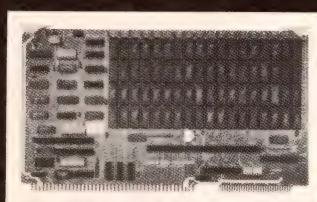
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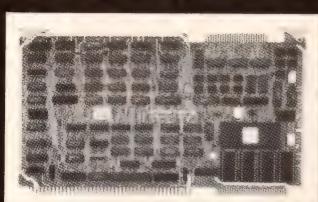
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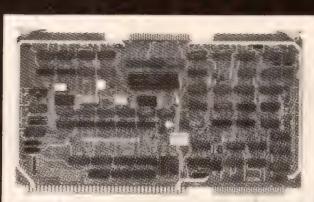
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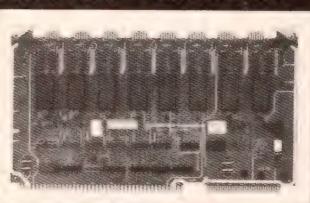
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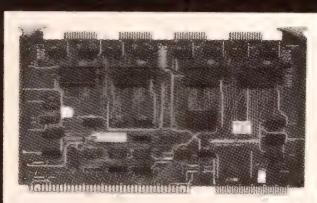
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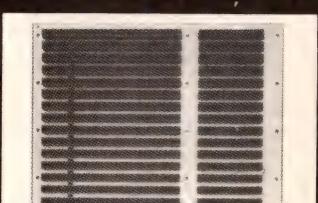
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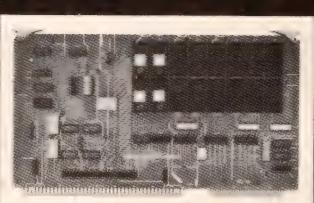
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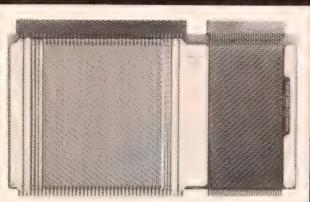
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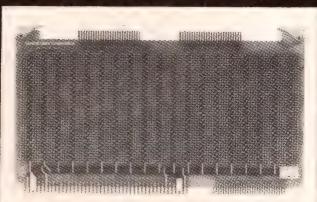
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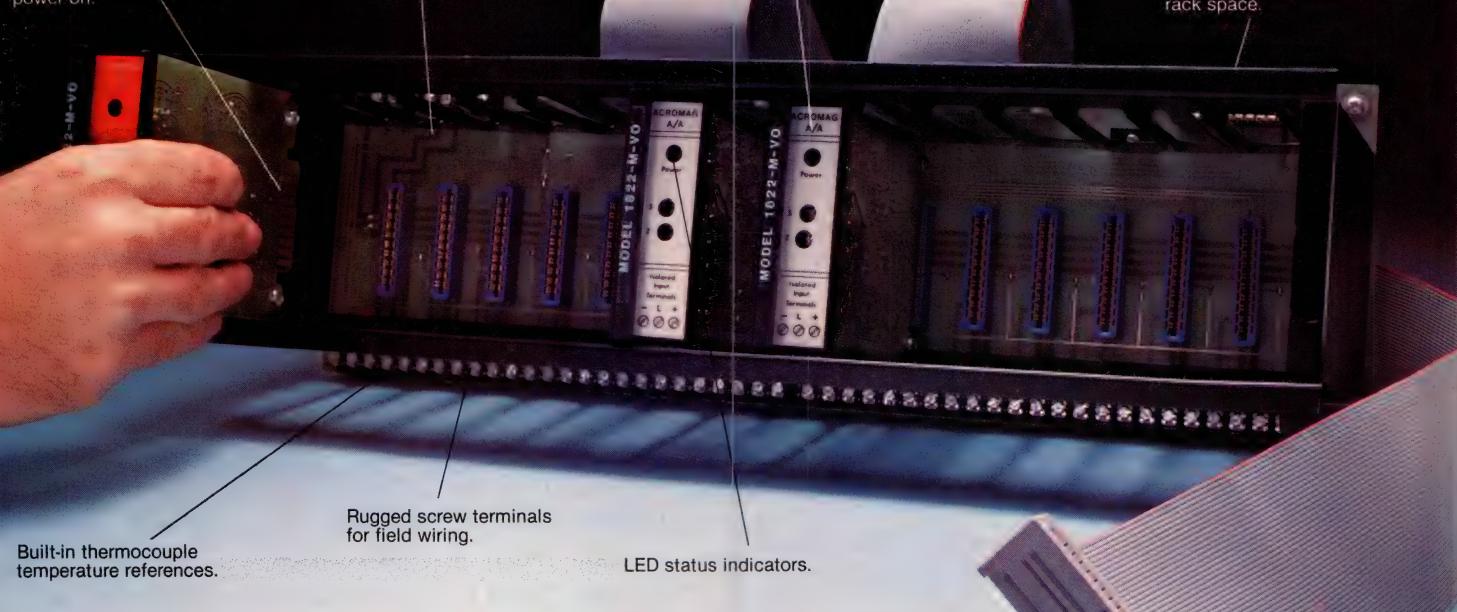
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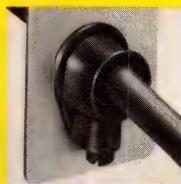
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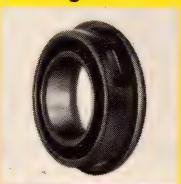
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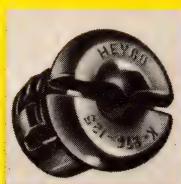
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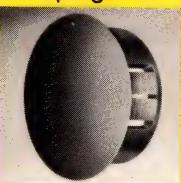


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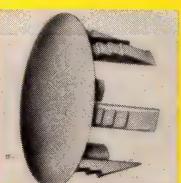
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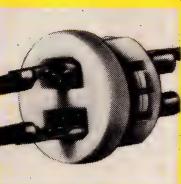
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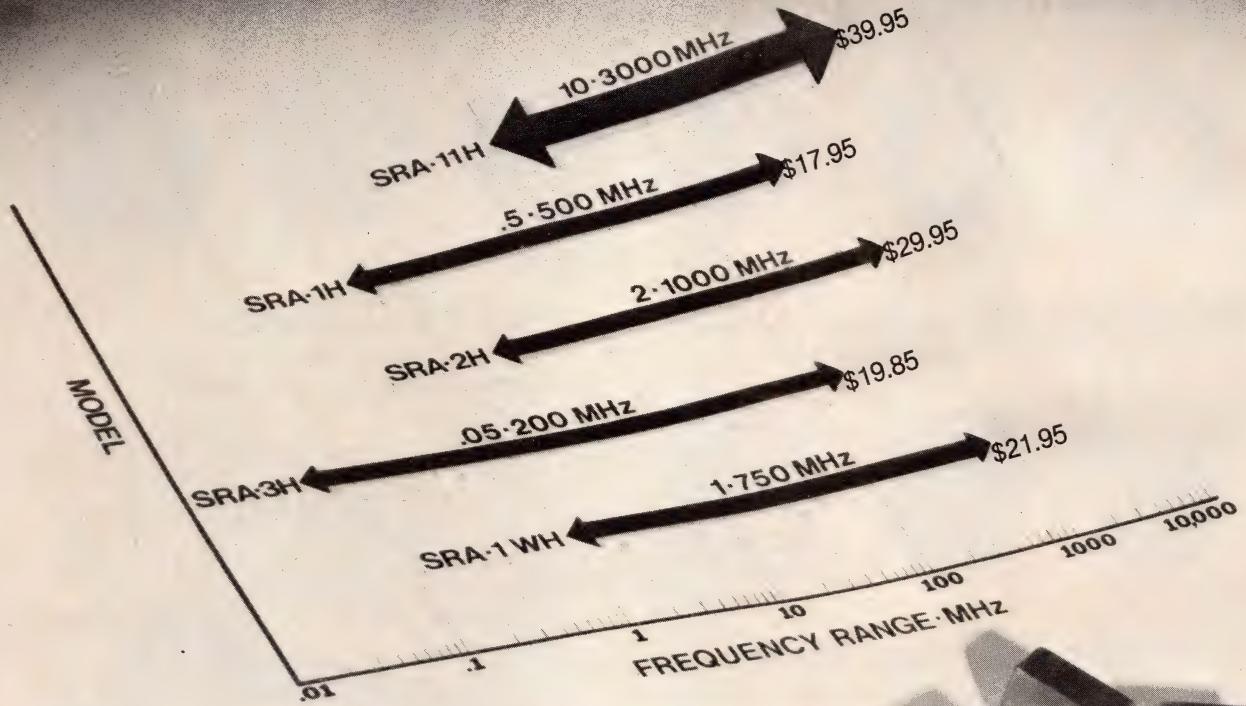
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William B Fox

Western Electric Co Inc, Columbus, OH

Testing a memory board thoroughly calls for more than just an instantaneous check of the memory's output state. ONEs should be high enough, ZEROs should be low enough and the output should remain within its specifications for a minimum length of time, the data-valid period (DVP). Not all automatic testers can perform these types of checks for each memory read cycle at full speed, but the circuit depicted in the figure does the job when used with an instantaneous-check memory tester. You'll need such a circuit for each bit tested.

Input DVP defines the test's time window. When this signal is LOW, both high-speed comparators are disabled and in a 3-state output mode. The pull-up resistors ensure that the state of the leading-edge-triggered data flip flop goes unaltered.

At the beginning of each test cycle, DVP goes HIGH, clocking the data from the memory under test (MUT) into the flip flop—whether that data is

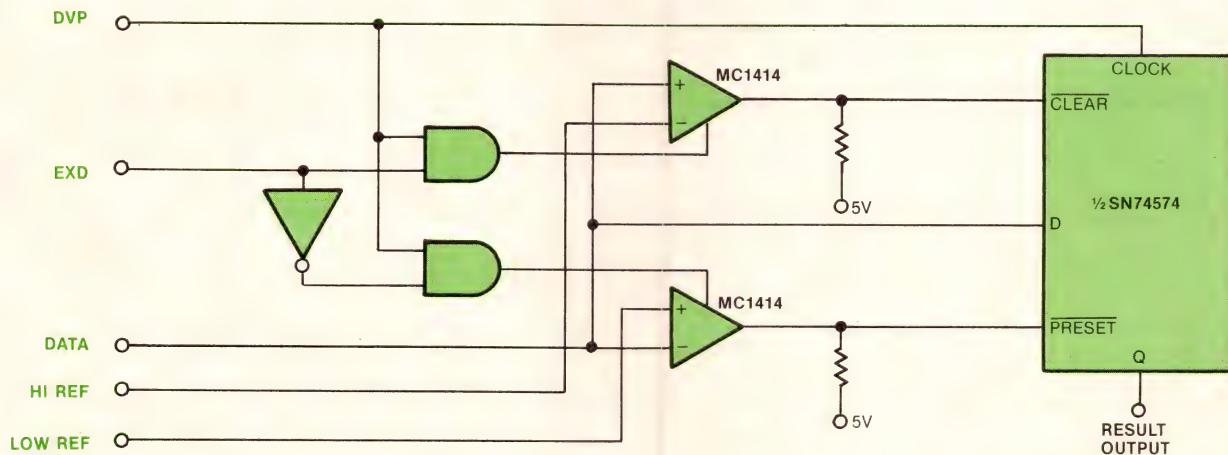
correct or incorrect. At the same time, one of the two comparators is enabled, depending on the state of EXD (the data the tester expects to see from the MUT).

Specifically, the high comparator's output goes LOW if the Data line is below the Hi Ref voltage and a ONE is expected, clearing the flip flop and providing the automatic tester with a ZERO when it expects a ONE. The flip flop remains uncleared so long as the data stays above Hi Ref during DVP.

On the other hand, the low comparator's output goes LOW if Data is above the Lo Ref voltage and a ZERO is expected, presetting the flip flop and providing the tester with a ONE when it expects a ZERO. The flip flop is not preset so long as the data stays below the Lo Ref during DVP.

As the test cycle ends, DVP goes LOW, allowing no further state changes in the Result output. Then the tester can check the Result line any time before the beginning of the next time window. **EDN**

To Vote For This Design, Circle No 457



Memory tests are complete only if each expected ONE or ZERO occurs during the allotted time frame. The Data Valid Period (DVP) input defines the test cycle time by clocking data from the memory under test into the Data input. If a ONE is expected and Data exceeds the Hi Ref level, the flip flop stores a ONE. If the ONE isn't high enough during DVP, a ZERO emerges from the Result output.

Design Ideas

One-shots detect frequency levels

John Dunn

Bertan Associates Inc, Syosset, NY

Fig 1 depicts a frequency-threshold detector you can construct with only two ICs and a "leftover" 2-input AND gate. Four retriggerable monostable multivibrators (one-shots) constitute the frequency discriminator: IC₁, IC₂ and IC₃ determine the threshold

frequency, while IC₄ serves as the over/under-flag generator.

The timing relationships shown in Fig 2 define the design's operation. Below the frequency threshold, pulse E₁'s rising edge lags E₃'s falling edge. At the threshold, this time lag equals zero. And above threshold, E₁ leads E₃. At the threshold, the AND gate's (IC₅) inputs are driven by the then-coincident E₁ and E₃ signals. The resulting output wave shape (E₁ · E₃) triggers IC₄, and the fixed-duration flag (E₄)

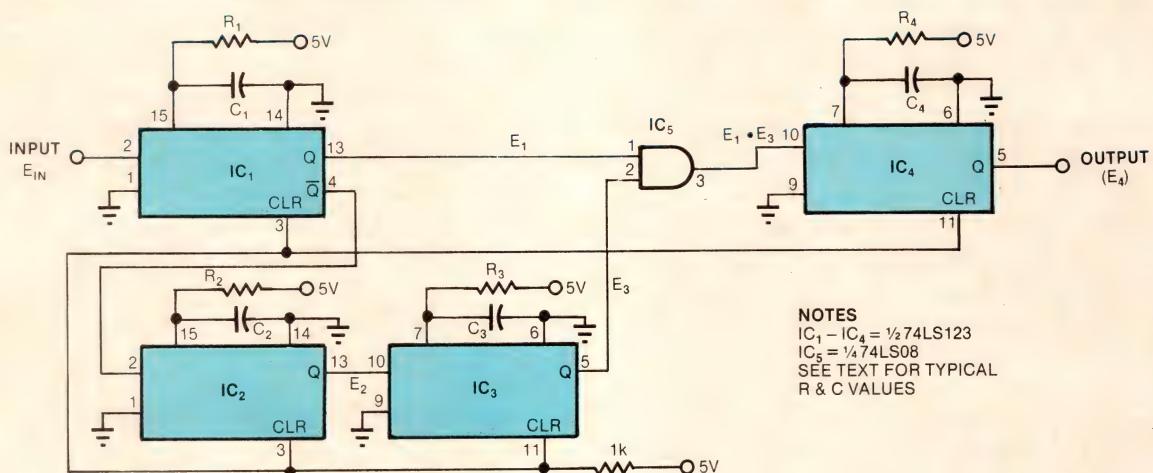


Fig 1—Frequency-threshold sensing results from comparing a retriggerable one-shot's durations with an unknown input frequency. So long as this frequency is lower than the threshold, the output (E₄) is LOW. But when the input exceeds the threshold, E₄ goes HIGH.

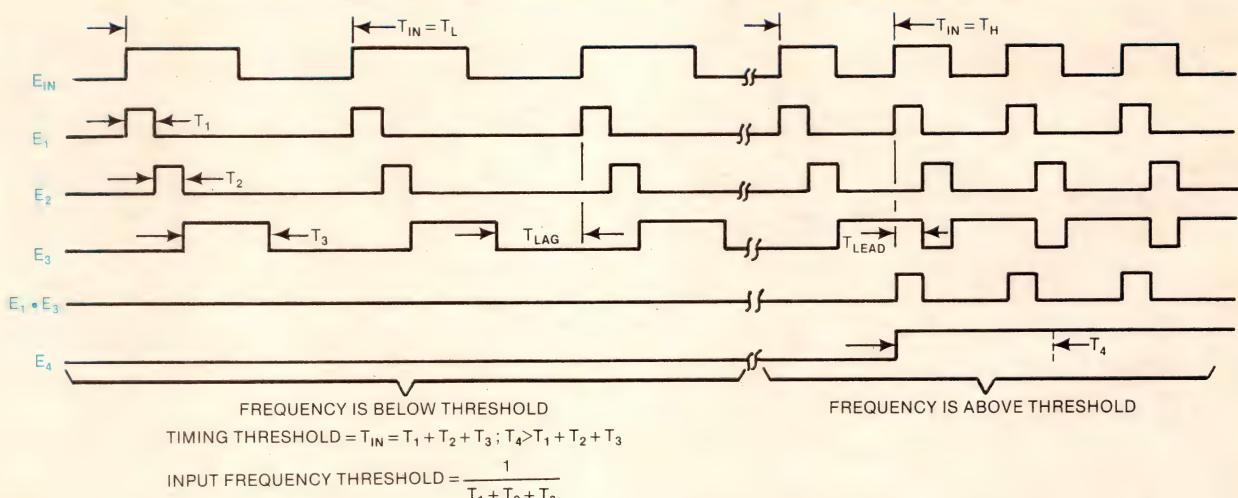


Fig 2—Whenever the input frequency (E_{IN}) is below the threshold frequency, E₁'s rising edge lags E₃'s falling edge, and the ANDed result (E₁ · E₃) stays LOW. However, when E_{IN} exceeds the threshold, E₁ leads E₃, and the ANDed result is HIGH. This transition triggers the output one-shot (IC₄ in Fig 1), and the E₄ flag goes HIGH for the period defined by T₄.

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For more information, Circle No 63

Design Ideas

appears.

Sample calculations of the pertinent time constants (Fig 2) demonstrate how you select component values:

$$T_1 = 0.45 R_1 C_1 = 0.45 \times 10k \times 220 \text{ pF} = 0.99 \mu\text{sec}$$

$$T_2 = 0.45 R_2 C_2 = 0.45 \times 10k \times 220 \text{ pF} = 0.99 \mu\text{sec}$$

$$T_3 = 0.45 R_3 C_3 = 0.45 \times 100k \times 0.022 \mu\text{F} = 990 \mu\text{sec}$$

$$T_4 = 0.45 R_4 C_4 = 0.45 \times 100k \times 0.047 \mu\text{F} = 2.115 \text{ msec.}$$

The resulting threshold frequency equals $1/(T_1 + T_2 + T_3)$ or 1008 Hz.

Note that the factor 0.45 used in these calculations

applies only when you employ LS-type one-shot devices. You can use standard 74123 types instead, but then the equation defining the pulse width becomes:

$$T_W = 0.28 R_X C_X (1 + 0.7/R_X)$$

Redoing the previous T_1 calculation yields a T_1 (and T_2) of 0.62 μsec .

EDN

To Vote For This Design, Circle No 458

One IC forms dual-pulse-width one-shot

James L Christensen

Ametek, El Cajon, CA

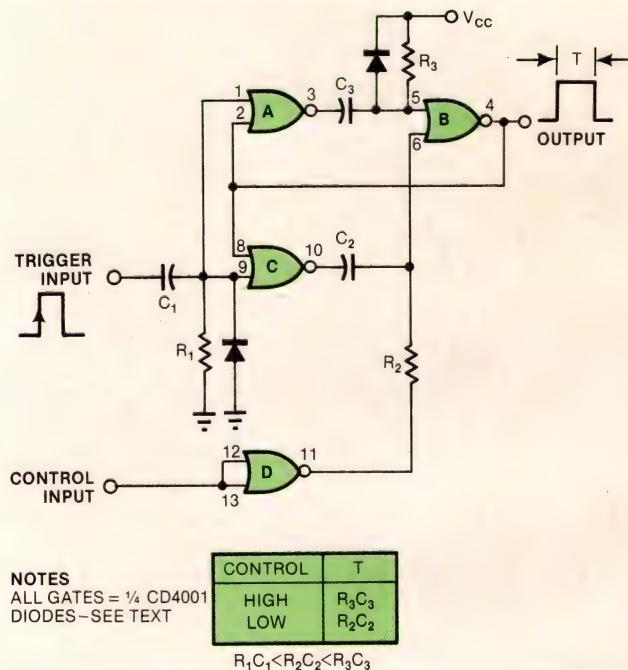
Pulse-width-modulation designs often require a generator whose output pulse width you can shift between two fixed time durations. The circuit shown in the figure provides this feature, along with complementary outputs: A positive-going pulse is available at the pin 4 output as a negative-going pulse appears at pin 3. The design calls for only one quad NOR-gate CMOS IC.

When the Control input (pins 12 and 13) is HIGH, R_2 is grounded, in turn enabling the output gate at pin 6. When you apply a positive Trigger input, gate A's output (pin 3) drops LOW, and this signal couples (via C_3) to gate B's input at pin 5. As a result, B's output switches HIGH, holding A's output LOW even after the trigger pulse disappears.

C_3 then starts discharging through R_3 , causing the voltage level at pin 5 to decrease exponentially toward V_{CC} . And when the voltage reaches the gate's high input threshold (about $0.7V_{CC}$), the output reverts to a LOW state and terminates the output pulse.

The alternative output pulse width occurs when the Control input is LOW. In that case, R_2 connects to V_{CC} via gate D. The one-shot action in this instance is similar to the HIGH control state, except that now the junctions of both $R_2 C_2$ and $R_3 C_3$ charge toward V_{CC} . However, because the $R_2 C_2$ time constant is the shortest, it reaches the gate's high input threshold first and terminates the output pulse.

You can realize a wide range of timing relationships with this basic design by observing two basic relationships:



Select two different output pulse widths with this design's Control input. When Control is HIGH, $R_3 C_3$ determines the output's duration; when it's LOW, $R_2 C_2$ applies.

$R_1 C_1 < R_2 C_2 < R_3 C_3$. Note that the minimum resistor values should be 10 k Ω . And also note that some manufacturers' CD4001 NOR gates might not incorporate internal input-protection diodes, so you might need to include the optional diodes shown in the figure when $V_{CC} > 9V$ and/or $C_x > 0.005 \mu\text{F}$.

EDN

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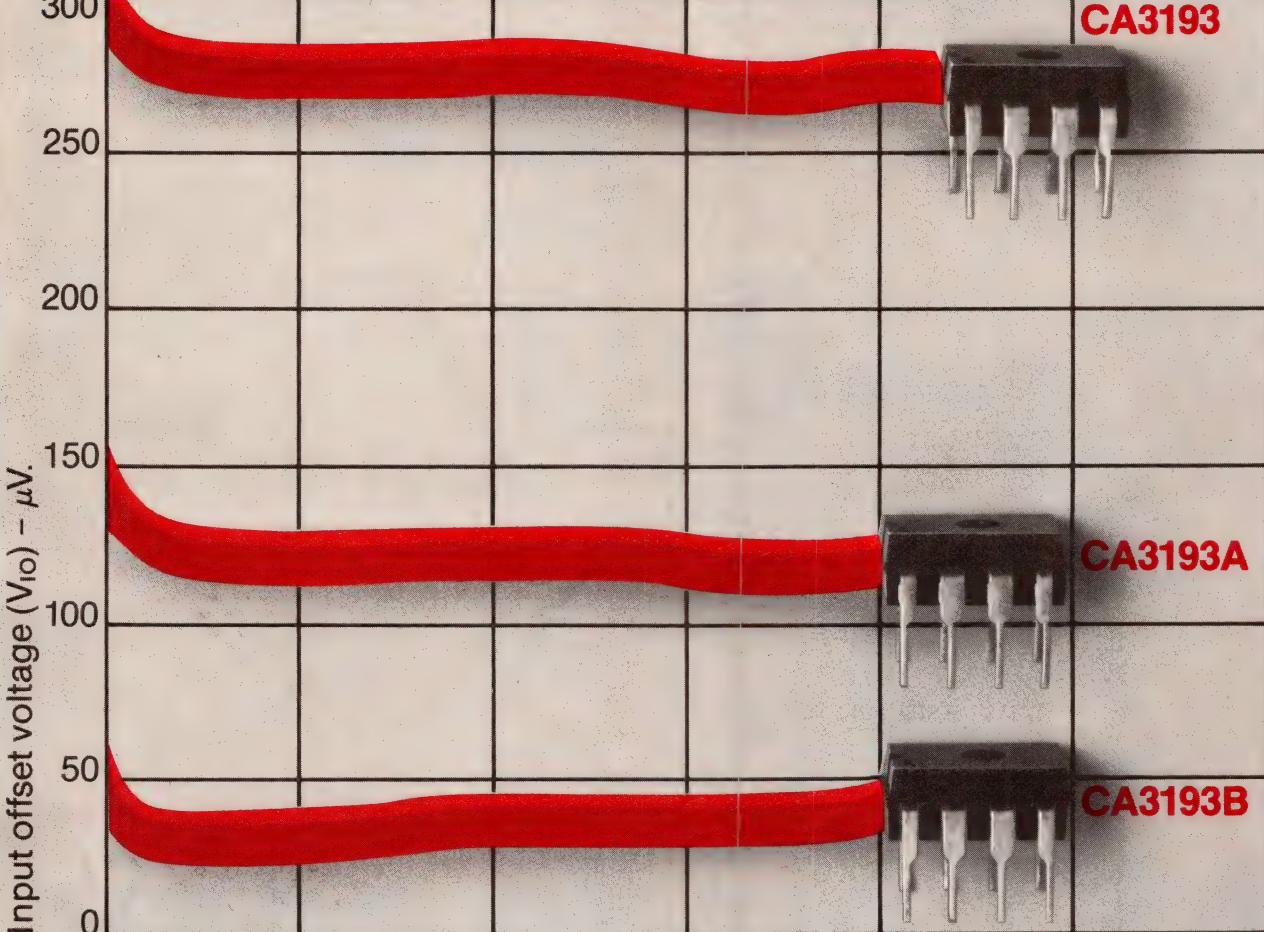
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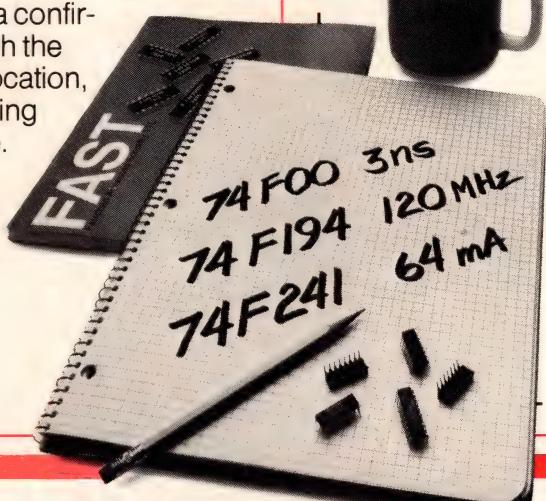
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Design Ideas

Switching scheme matches supply to mains

Donald J Brown
db Products, Noblesville, IN

This power-supply design can meet solid-state low-voltage requirements when powered from a wide variety of input-mains voltages—a feature that makes it ideal for any equipment slated for international use. As shown, it provides 12V at 1A. However, changing the components' voltage and/or current limitations alters the design to suit your needs.

Power-supply operation, filtering and regulation all follow well-established rules; the design's novelty lies in the use of switch S_1 to handle wide input-voltage variations while still providing the desired output. Note that S_1 can be either a physically actuated switch accessible to the user or a relay automatically thrown upon insertion of the proper US or non-US (usually 220V ac) cord into a back-apron receptacle.

The design's key feature is simplicity. When the switch is in the 120V ac position, the transformer operates with the full secondary voltage applied to a bridge-rectifier system, whose filtered dc output goes to the regulator.

In the 240V ac position, on the other hand, the transformer is center tapped, supplying the rectifiers with half the transformer's available secondary ac voltage. The bridge thus becomes a full-wave-rectifier system (ignoring two of the diodes), and a filtered dc output at approximately the same voltage goes to the regulator.

You can redesign the supply to meet your own particular needs by applying textbook design formulas to it in both configurations. Then use the higher voltage and current requirement that each

component part requires.

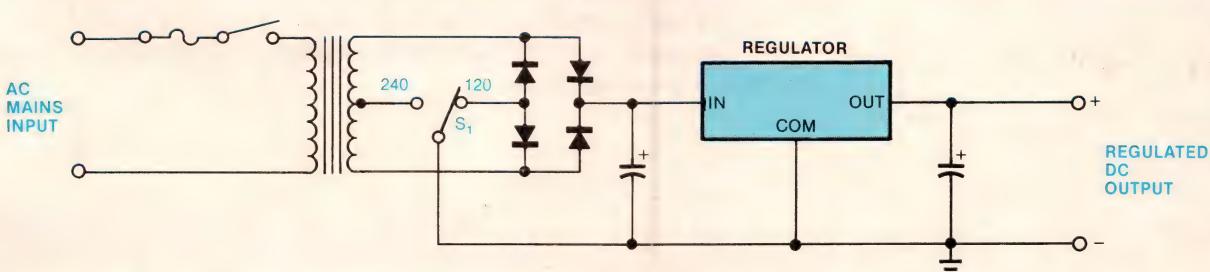
This action satisfies all the requirements for dual-input-voltage use, but what of the variations arising in international usage? The transformer might have to be a 50-Hz unit rather than a 60-Hz model to accommodate the more common 50-Hz mains frequency found in international applications. Additionally, many countries have only 105V ac as the nominal voltage, or perhaps 200V ac as a high tap input. Therefore, calculate the transformer, diode and filtering values to maintain the filtered dc feeding the regulator above its spec'd minimum input. Furthermore, carefully watch diode PIV rating, the filter capacitor's maximum voltage limits and such parameters as the regulator's maximum dc input limits.

Transformer selection is often the most troublesome part of a power-supply design. You could employ a unit designed for international applications, but such units are generally difficult to locate off the shelf and more expensive than domestic versions. Alternatively, nearly all filament or solid-state-rectifier transformers are designed for 50- and 60-Hz operation. And their primary windings—although rated for only 120V ac—can also generally withstand 240V ac.

S_1 offers the other cost-savings feature. By voltage-range switching in the secondary, you no longer need a switch capable of handling the very high voltages employed in Europe. True, S_1 must carry higher currents when used on the secondary side, but because you won't be switching modes during normal operation, this requirement shouldn't present a problem.

EDN

To Vote For This Design, Circle No 460

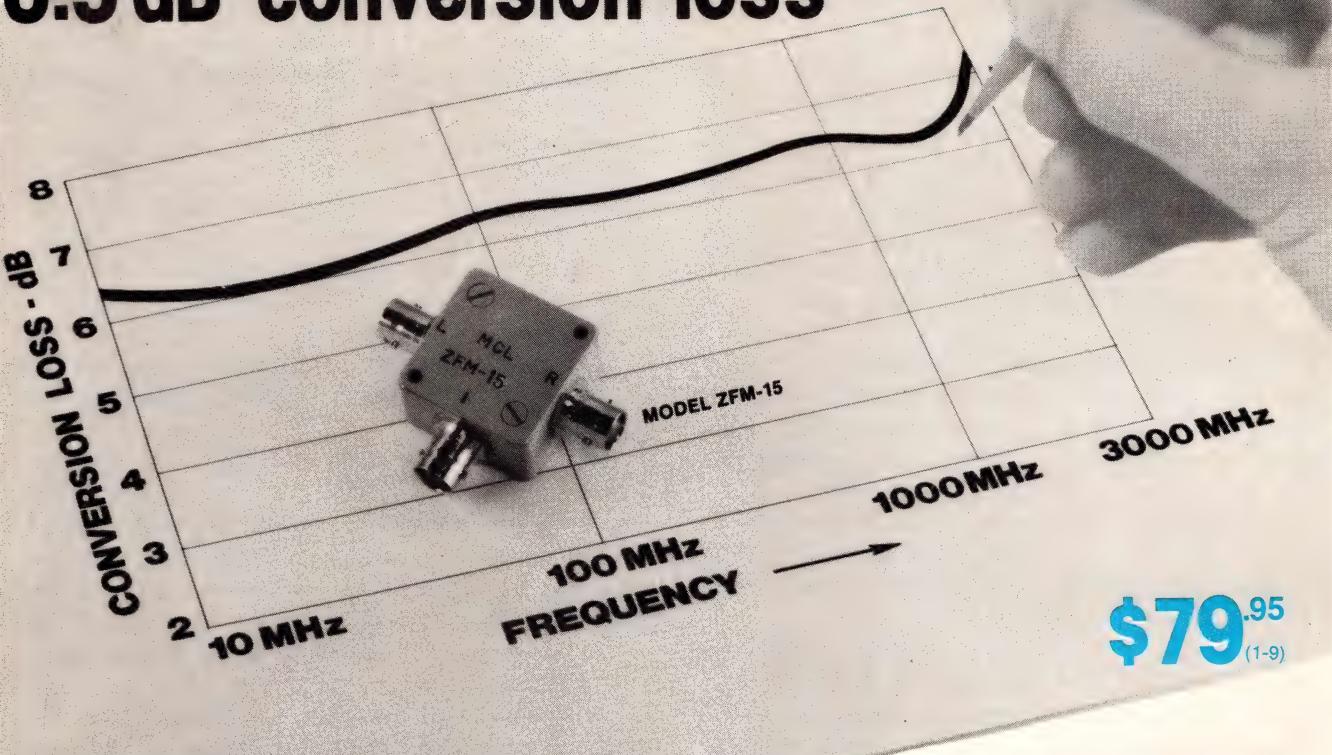


Switching the transformer's secondary offers a simple and cost-effective way of handling the differences between US and European mains voltages. The scheme uses the diode bridge in a 4-diode, full-wave configuration when in the 120V position and in a 2-diode setup in the 240V mode.

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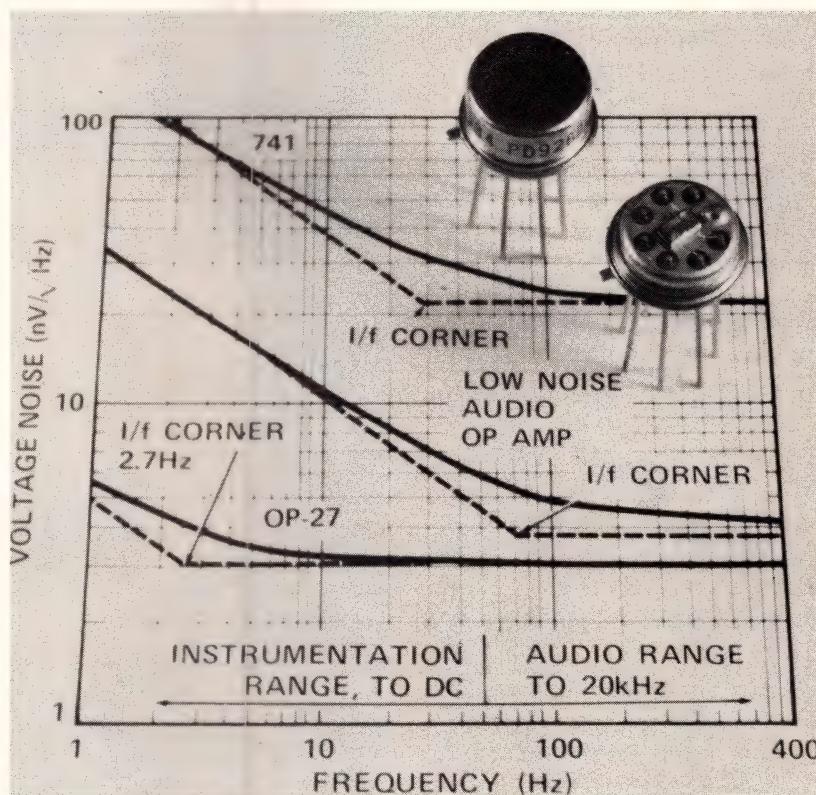
With 3.8-nV/ $\sqrt{\text{Hz}}$ max input noise-voltage density, this device sports the lowest noise of any op amp on the market. But its speed also stands out: Slew rate equals 1.7V/ μsec min and 2.8V/ μsec typ. And precision is also noteworthy: 25- μV input offset voltage, 35-nA input offset current and long-term V_{os} drift of 1 $\mu\text{V}/\text{month}$ max.

Although such specs are available separately in other devices, this part is the first to successfully combine them in a monolithic chip. Other impressive specs include average input-offset drift of 0.6 $\mu\text{V}/^{\circ}\text{C}$ max, typical large-signal voltage gain of 1 million, 5-MHz min gain-bandwidth product and input noise voltage of 0.18 μV p-p max over 0.1 to 10 Hz.

DC specs not compromised

While offering some performance improvements over the OP-07, the OP-27 retains its predecessor's dc performance. For instance, common-mode rejection ratio is typically 126 dB, and power-supply rejection is 120 dB.

Bias current specs at ± 40 nA, a low figure attributable to a bias-current compensation network at the inputs. With this scheme, the direction of bias-current flow varies with the magnitude of the current fed to the base of the device's npn input transistors by its pnp current sources.



In one monolithic device, the OP-27 combines the lowest noise of any op amp with noteworthy precision and speed specs.

This characteristic could make the device unsuitable for some applications, such as rectification or precision ac-voltage conversion, where you must know the current direction. However, the part suits applications in which source impedance is very low, such as strain gauges, 3-op-amp instrumentation amps and precision integrators or differentiators. And it also suits production environments where use of a trimming pot is undesirable or too expensive.

Power consumption is 140 mW, slightly higher than that of the OP-07 because of the higher input-stage currents required

for noise reduction. Additionally, the OP-27 has diode-protected inputs but no protection resistors, so large common-mode voltages (greater than approximately 12V) could damage the input section.

The OP-27 comes in the same package types as the OP-07 and with the same pinouts. \$5.50 to \$50 (100), depending on grade and temperature range.

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246-9222. Circle No 453

Large-format Z8000-based plotter departs from conventional designs

Unlike conventional rotating-drum or fixed-bed plotters, Model 7580A moves the plotting medium in one direction over an airfoil-shaped bed while its lightweight pen carriage moves perpendicularly to the medium's direction of motion. The low-mass, low-inertia mechanisms required for this design permit the use of smaller and less expensive motors and drivers. There's no compromise in performance, though: The Z8000-based unit achieves 24-ips maximum speed, 0.001-in. resolution and 0.002-in. repeatability—figures comparing favorably with those of more expensive machines. Pen heights range from 0.032 in. for short movements to 0.065 in. for long ones, ensuring maximum throughput.

The 7580A accommodates plotting-medium sizes ranging from 8×10.5 to 24.5×46.85 in. It holds the paper, vellum or polyester-film medium in place with a microgrip device consisting of a rubber pressure wheel and a textured drive wheel.

Upon loading, the unit senses the medium's size using photocells; a reed relay in the pen carrier is actuated by a magnet in the right-margin adjustment and allows the 7580A to determine the appropriate boundaries and scale.

Holds eight pens

The manufacturer supplies pen carousels that hold as many as eight fiber-tip, ball-tip or drafting pens. Each cartridge in a carousel employs a pen cap to keep its pen wet when not in use, and each carousel is coded



As the plotting medium moves through it, Model 7580A moves its pen assembly perpendicularly to the medium's direction of motion.

to automatically inform the system of the type of pen in use. The system can then automatically adjust pen pressure and acceleration.

The 7580A permits automatic pen selection under program control. Therefore, it can create multicolor plots such as pc-board layouts.

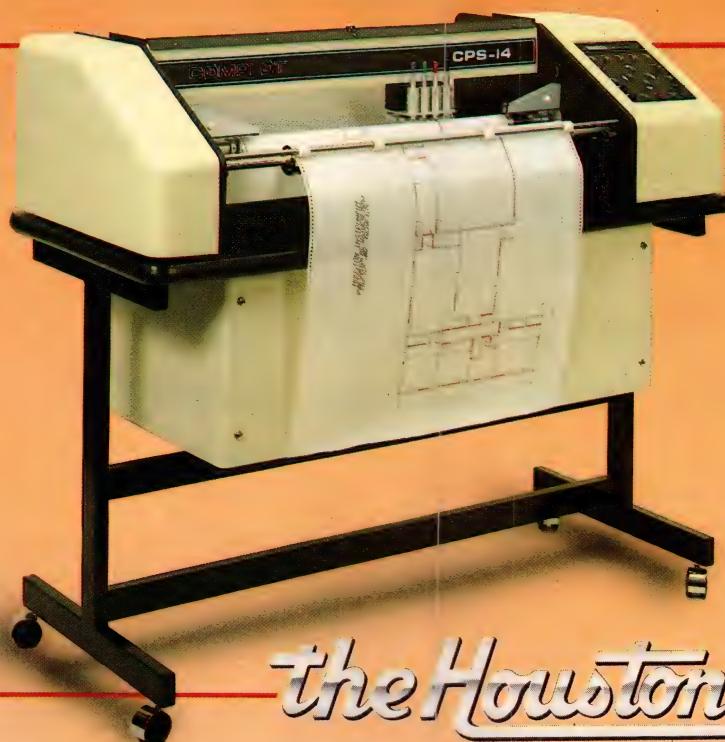
Joystick control available

The unit's 48k-byte ROM not

only supports plotter operation, but also provides six character sets, including special mathematics and centering symbols. Front-panel controls include a joystick that permits movement of the pen carriage to any point on the paper for making critical alignment marks.

The plotter accepts data inputs and commands from a variety of interfaces, including IEEE-488 and RS-232. If you

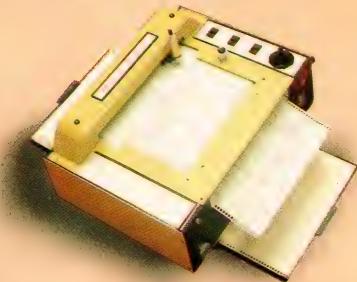
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ARO.

Hewlett-Packard Co, 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office. Circle No 454

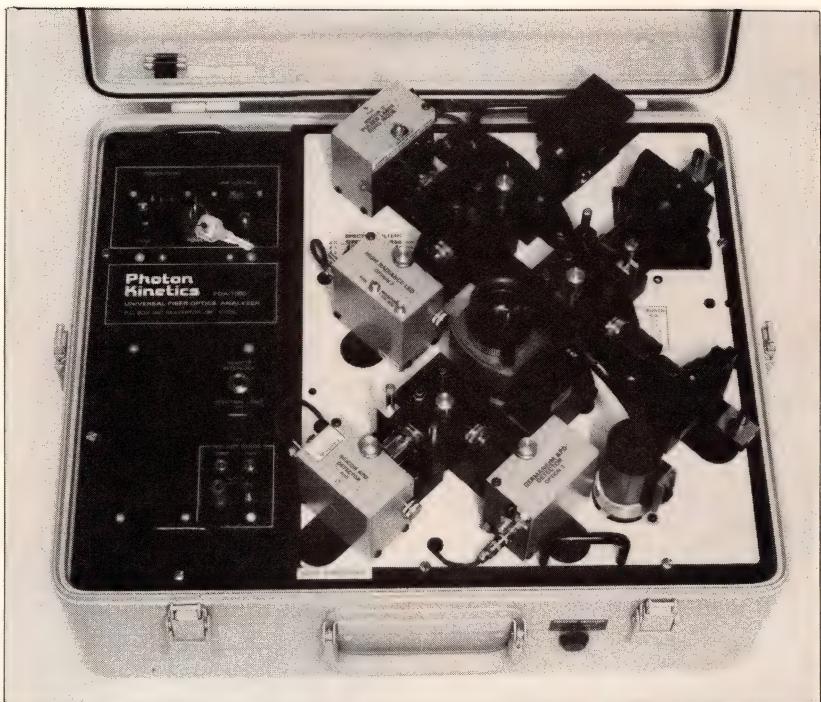
Universal fiber-optics analyzer handles lab, field measurements

Just attach the FOA-1000 to a suitable oscilloscope and you can measure the attenuation of long fibers, along with spectral attenuation, pulse dispersion, bandwidth, transfer function, numerical aperture (NA), optical power and index profile. The instrument can also perform optical time-domain reflectometry to locate fiber breaks and evaluate connector-splice losses—an especially useful function for evaluating fibers in the field.

The analyzer's emitter section accommodates two semiconductor emitters and a halogen lamp. The standard source is a single heterojunction laser diode and associated pulser electronics, providing a Q-switched pulse with 200-psec rise time and 300-nsec width. You can use this source for all measurements except spectral attenuation; for those, use the halogen lamp.

In addition, you can install your own sources or detectors for evaluation in the unit's source/detector mounts. A knob provides rapid switching between sources, and a launch-NA wheel restricts the angle of a source's light cone as it enters the fiber, controlling mode excitation.

In addition to the standard silicon avalanche photodiode (APD), the FOA-1000's detector section accommodates one



Complete characterization of optical fibers is possible with the FOA-1000 universal analyzer. Equipped with a suitable scope, it measures attenuation, numerical aperture, bandwidth, pulse dispersion, optical power and index profile.

optional detector. The standard APD has a 150-psec typ rise time and functions at wavelengths as long as 1050 nm; an optional germanium APD accommodates measurements up to 1700 nm. And with an optional calibrated PIN diode, you can measure absolute optical power emission (both continuous wave and pulsed), as well as the power budget through the fiber under test.

You can mount either of the optional detectors in the detector mount's alternate

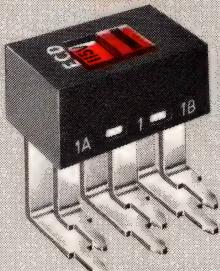
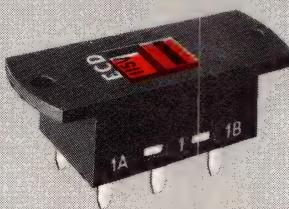
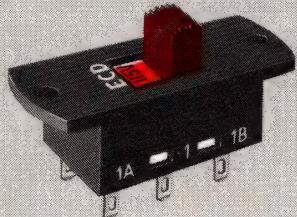
position and inject its output into the measurement loop with a switching mirror. A set of neutral-density filters keeps each source's dynamic range within each detector's range.

The FOA-1000 operates from 115 or 230V ac and draws 50W. To enhance portability, an optional case locks all components in position for safe transit. \$9500.

Photon Kinetics Inc, Box 1481, Beaverton, OR 97075. Phone (503) 644-1960.

Circle No 455

A FLIP OF THE SWITCH CONVERTS FROM 115V TO 230V



SE Series Switches
Pat. Applied For

THE ALL AMERICAN SWITCH DESIGNED TO MEET UL AND VDE STANDARDS

SHELF STOCKED FOR IMMEDIATE DELIVERY!

Designed to meet the needs of manufacturers throughout the world, these sophisticated switches are designed to meet requirements of UL, VDE, CEE, CSA, SEMKO and DEMKO.

This new series offers a choice of actuation either by screwdriver slot or raised handle, available with a wide variety of terminal styles.

Contact Walt Dinneen, Switch Product Manager
For Engineering Information & Sample

AMF

Electro-Components Division
2713 Gateway Drive, Pompano Beach, Florida 33060
Tel.: 305/973-8620 TWX: 510/956-9400

AMF Electro-Components Division manufactures RCL Resistors, Delay Lines, Switches & UID Switches

Feature Products

Low-cost mechanical keyboard arrays feature rigid monolithic construction

The KS-200 keyboard arrays' unitized housings lend themselves to inexpensive keyboard-system design. They eliminate the need for pc-board stiffeners, reduce assembly labor and inventory costs and minimize keyswitch- and keycap-alignment problems, according to the manufacturer.

The KS-200 line includes standard 54- and 62-key layouts, numeric pads in 11-, 14- and 18-key formats and ancillary arrays of 1×2 through 5×6 stations. All units employ Form A (spst, normally open) twin bifurcated contacts of phosphor-bronze with a precious-metal inlay, rated from dry-circuit conditions to 10 mA at 5V dc resistive. You can replace contacts with an inserter tool in a few minutes.

Keyswitch plungers have legs that dampen downstroke to



The monolithic housing design of KS-200 arrays provides a low-cost approach to keyboard-system design. Versions include numeric pads and ancillary standard arrays as well as standard 54- and 62-key designs.

improve feel, and you can

specify momentary or alternate action. Lifetime specs at 20×10^6 or 5×10^6 operations, and operating force measures 2 oz or 3.5 oz (to latch).

Additional specs include 100-mΩ initial contact resistance, 5-msec max contact bounce (1 msec typ) and 500V rms dielectric strength.

All arrays are compatible with wave-soldering techniques, and you can choose from a wide selection of double-shot caps in various sizes and colors. You can also purchase the arrays without keycaps and/or pc boards. Less than \$30 (5000) for 54-key array with caps and pc board.

**Stackpole Components Co,
Box M, Farmville, VA 23901.
Phone (804) 392-4111.
Circle No 456**

NEXT TIME

EDN's February 4 issue will feature a Special Report on switching power supplies, plus useful articles on

- A versatile over/undervoltage-protector IC
- The design of a low-cost but highly accurate electronic watt/watt-hour meter
- A program for performing network analysis on a desktop computer

- The modeling of memory-system reliability
- Techniques for holding productive meetings

... and much more. Also look for preview coverage of ISSCC 81 and a news roundup of the latest product developments in small rigid- and floppy-disk drives, plus our regular Design Ideas, μC Design Techniques and Looking Ahead departments. You can't afford to miss this issue!

EDN: Everything Designers Need



Codex cuts weeks off design cycle with PC-800.

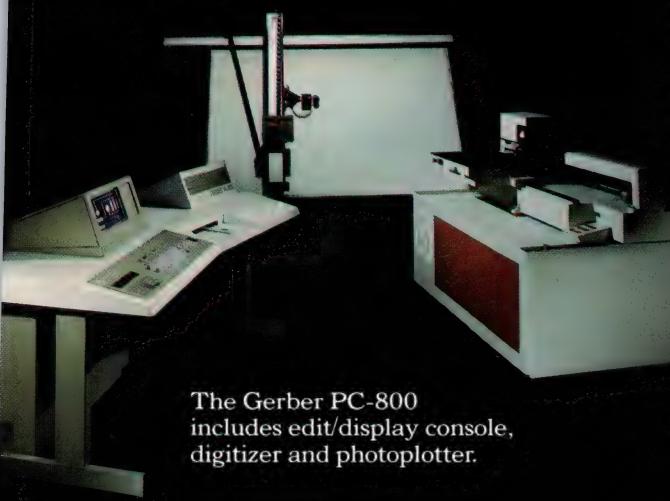
The Gerber PC-800 CAD system is helping Codex, a subsidiary of Motorola, increase its share of the fast-paced data communications market.

How? By speeding up PCB artwork production so much that the critical product development cycle has been shortened by weeks. The result: Codex gets products to market faster – at lower costs.

With PC-800, Codex produces 1:1 master artwork with accuracy hand taping can't match. Registration is perfect, eliminating costly manufacturing errors. And Codex can put more runs in the same space – avoiding the cost of bigger boards.

PC-800. It's the proven CAD system that cuts turnaround, boosts productivity and improves board manufacturability. And you can justify it even if you produce as few as 10 PC designs a year.

It works for Codex. And it can work for you.



The Gerber PC-800 includes edit/display console, digitizer and photoplotter.

Gerber PC-800
The CAD success story of the year.

GSI™ **The Gerber Scientific Instrument Company**

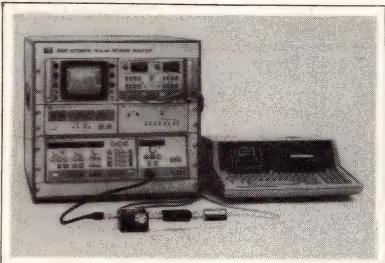
A Gerber Scientific Company,
83 Gerber Road, South Windsor, CT 06074 / 203-644-1551

See us at NEPCON West Booth 2322.

For more information, Circle No 68

New Products

INSTRUMENTATION & POWER SOURCES



SCALAR ANALYZER. Suiting the measurement of insertion loss or gain and the return loss of devices, components and networks, Model 8755P measurement system covers the 0.04- to 18-GHz range.

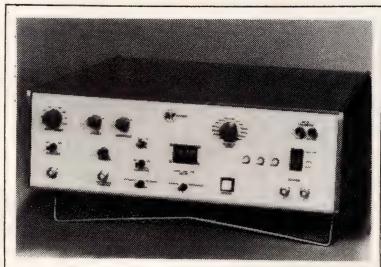
The system contains a Model 8350A sweep oscillator with its 10-MHz to 20-GHz RF plug-in and a Model 8755S frequency-response tester, both under the command of Model HP85F controller. System control is via the company's HP-IB interface bus.

The IEEE-488-compatible system's standard software permits automatic calibration and measurement of as many as 500 points of either insertion or return loss or as many as 250 points of both; automatic scaling and displaying of a plot of measured parameters versus frequency; and printing or displaying of measured data in tabular format. The measurement program (in enhanced BASIC) permits customizing for specific measurements.

Basic performance characteristics include 60-dB dynamic range for all detector inputs, test-signal-frequency accuracy of ± 20 MHz at 20 GHz and power-level accuracy of ± 1.5 dB at 20 GHz. \$45,930. Delivery, 20 wks ARO. 2- to 18-GHz version, \$38,880. Delivery, 8 wks ARO. **Hewlett-Packard Co**, 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office. **Circle No 181**

μ V ALIASING FILTERS. For use ahead of low-level multiplexers or amplifiers, these capacitively coupled active filters are balanced, isolated and floating. Noise insertion specs at less than 2.5 μ V rms. The filters' 7-in.-high rack-mounting modules each accommodate 10 pc boards. 5200 and 5300 Series models include six 2- or 3-pole filters per board; 5400 Series models include three 4-pole filters per board. 5600 Series models provide two 2-pole filters per board. Filter types include Butterworth, Chebyshev, PILAF (phase in-band linear amplitude flat) and Bessel. Rack module, \$300; filter board, \$685 to \$733. **Instrum**, 2738 W Main St, Alhambra, CA 91801. Phone (213) 682-3419. **Circle No 182**

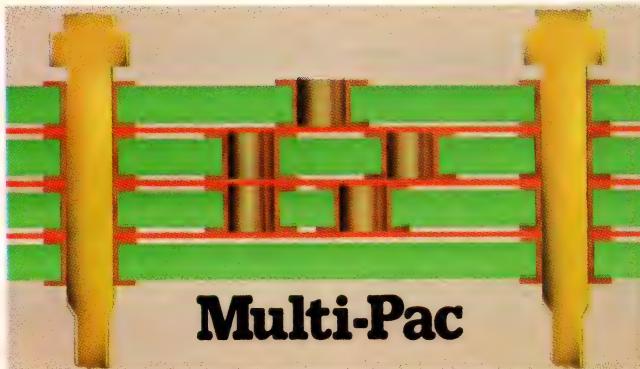
MEMORY ATE. Designed for incoming-inspection and production applications, System 7800 includes one or two fully loaded test heads. It tests most TTL and ECL devices and MOS static and dynamic RAMs and ROMs, and with its complement of 27-input/10-output pins can test 64k \times 8 RAMs and 64k \times 10 PROMs. 25-MHz clock rates are standard for all test patterns; a split-cycle technique permits 50-MHz testing. Other features include data-reduction capability, overall system accuracy of 0.5 nsec; 1-nsec I/O switching; 16 timing sets; 32 timing-mask sets; programmable active loads and pin-selectable timing, formats and levels. A DEC LSI-11/23 computer with up to 128k words of memory controls system operation. High-level software is based on DEC's RSX-11/M multitasking operating system. From \$250,000. **Accutest Corp**, 25 Industrial Ave, Chelmsford, MA 01824. Phone (617) 256-8124. TWX 710-347-0620. **Circle No 183**



TRANSIENT RECORDER. Model PR-7902 can capture 4096 points of an analog waveform with sample rates to 20M samples/sec and 8-bit resolution. A 10-MHz bandwidth and ac and dc coupling suit it for use with 10:1 oscilloscope probes. Triggering capabilities include autotriggering, adjustable pretriggering and delay triggering. μ P control facilitates custom interfacing; RS-232C and GPIB interfaces and an 8192-point memory are optional. \$3500. **Micro Pro Inc**, Rte 309 and Advance Lane, Colmar, PA 18915. Phone (215) 822-8971. **Circle No 184**

DEVELOPMENT SYSTEMS. Units in the Scoutsystem Series for 6800/6809 μ Ps provide up to 64k bytes of RAM and 2M bytes of disk storage. Configured with a 1920-character CRT and either dual 5 $\frac{1}{4}$ - or 8-in. floppy-disk drives, these systems incorporate the firm's Hunter shortcut debugging package, allowing memory, register and stack contents to be inspected and changed. Other features include an assembler that uses standard Motorola assembler directives and provides relocatable code, an MDOS conversion package, text editor and text processor. The units also furnish memory diagnostic routines for identifying failed memory chips. \$5700 to \$7745. **Smoke Signal Broadcasting**, 31336 Via Collinas, Westlake Village, CA 91362. Phone (213) 889-9340. **Circle No 185**

Multi-Pac® edges out Multilayer in the photo finish.



Even though Multi-Pac is used by many O.E.M.'s some people still consider us a dark horse. That's OK ... a winner has to come out of the pack to be recognized. At Elfab, we've done it with press-fit technology. We were the first. And since that time we've set a fast pace as a leader in the industry. Now we want to set the pace with Multi-Pac, our innovative assembly of stacked PC boards held together in a "sandwich" with press-fit contacts.

Multi-Pac or multilayer. At Elfab you can win either way, no matter what your preference, because we do make them both. Examine the competitive differences closely and see if you don't agree with us that Multi-Pac comes out ahead.

The Difference Is:

Pole Position: Multi-Pac costs 10-15% less.

Second: With Multi-Pac you can have via or pass-thru holes from plane to plane. Whereas with multilayer holes must be drilled through all circuit layers prohibiting circuitry in that area.

Multi-Pac gives you up to 8 layers of circuitry, or solid copper sheets can be used in place of PC boards for high current capacity.

Third: Guaranteed controlled impedance with uniform board spacing. Great for high speed logic circuits.

Fourth: Multi-Pac lets you build Hybrid systems into any part or all of the board. Unlike multilayer, with Multi-Pac you can stack additional circuit layers on sections of the backpanel or daughter board where additional density is needed.

Fifth: Because Multi-Pac is a stack of discrete PC boards, any board can be changed right up to assembly time (when the contacts are pressed in place).

Sixth: Repairability — Contacts can be removed with Multi-Pac, and circuit layers can actually be assessed for changes or repairs.

Seventh: Moisture-in-Moisture out. Multi-Pac meets MIL-STD 202 method 103 test B for humidity; and 101 test B for salt spray.

Eighth: Properly done, your art work can be interchangeable with multilayer and Multi-Pac. Thus, you always have two sources.

The odds favor Multi-Pac ... bet on it! Write or call us for additional information.



ELFAB

The Leader in Press-fit Technology

P.O. Box 34555, Dallas, Texas 75234, 214-233-3033

For more information, Circle No 69

New Products

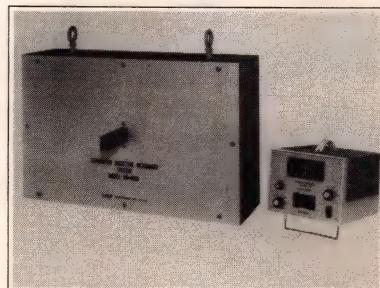


4½-DIGIT DMM. Model 255 features 10- μ V sensitivity on its lowest dc-voltage range and permits measurements to 1000V dc at 0.03% basic accuracy. AC-voltage measurement capability spans 10 μ V to 5000V. You can measure ac and dc current from 10 nA to 2A; resistance, from 0.1 Ω to 2 M Ω . Both ac voltage and current are measured with an average-sensing technique, which furnishes full accuracy from 50 to 5000 Hz and an extended range past 2.5 kHz. The unit's basic TC specs at 30 ppm/ $^{\circ}$ C. Housed in the firm's 5½×1½×3½-in. case, the

<1.3-lb instrument includes a 0.4-in.-high black-on-silver LCD and two front-panel rotary switches for 1-function range selection. Overvoltage protection equals 1000V on all voltage ranges and 250V for resistance ranges; an internal 2A fuse protects current ranges. \$279. **Data Precision Corp**, Electronics Ave, Danvers, MA 01923. Phone (800) 892-0528; in MA, (800) 343-8150. TLX 921819.

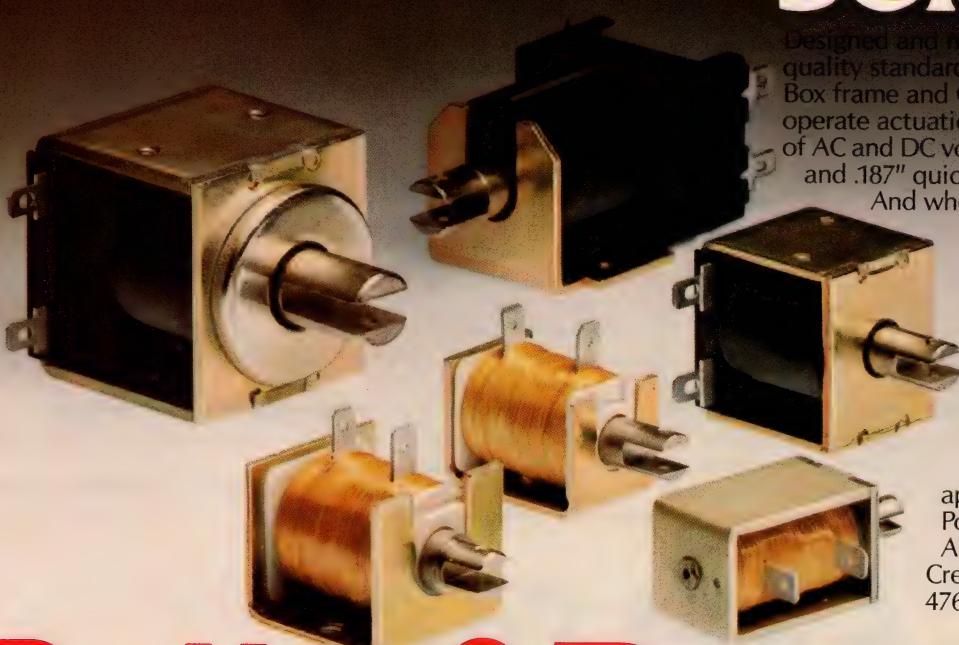
Circle No 186

INDUCTION MEASURER. Model SM-8100 saturation-induction-measuring system measures electromagnetic units (EMU) of magnetic materials and displays the results on a 3½-digit panel meter. It tests samples with lengths to 1.5 cm and volumes to 15 cm³. Permanent



magnets and a soft-iron core produce a magnetic field of 9500 Oe that saturates the magnetic sample. A scale factor normalizes the sample's weight, allowing direct readings in EMU. The device suits applications requiring measurement of permeability of weakly magnetic materials such as stainless steel. \$8700. Delivery, 12 to 14 wks ARO. **LDJ Electronics Inc**, 1280 E Big Beaver, Troy, MI 48084. Phone (313) 689-3623. TWX 810 232-1509. **Circle No 187**

Solenoids



Designed and manufactured to the same high quality standards you expect of all P&B products. Box frame and C-frame designs, with pull-on-operate actuation, are available in a wide range of AC and DC voltages. Class A (105° C) insulation and .187" quick connect terminals are standard.

And when a standard solenoid won't do, P&B will design one specially to meet your requirements. Special terminations, mountings, plunger end configurations, duty cycles and intermediate voltages are but a few of the options available. We can also design special solenoid assemblies for a wide range of applications.

Potter & Brumfield Division,
AMF Incorporated, 200 Richland Creek Drive, Princeton, Indiana 47671. (812) 386-1000.

Potter&Brumfield

For more information, **Circle No 108**

New Products



CALIBRATOR. Suiting the calibration of industrial control devices and meters, Model 334 features 4-digit thumbwheel switches and 0 to ± 11.999 V dc and <1 to 119.99 mA outputs. Accuracy specs at $\pm 0.01\%$ FS: resolution equals 1 mV, 10 μ A. To eliminate transients during level selection, the unit includes a Hold switch that keeps the output near its previous level while you change the

thumbwheel-switch setting. When you release the Hold switch, the output immediately steps to its new level. The unit measures 21 \times 8.9 \times 28 cm and weighs 2.5 kg. \$795. **Exact Electronics Inc**, Box 347, Tillamook, OR 97141. Phone (503) 842-8441. **Circle No 188**

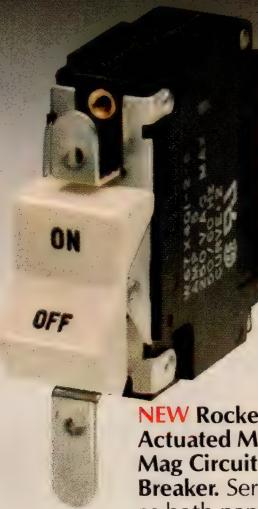
TEMPERATURE PROBE. To permit accurate measurement of rapidly cooling objects, Model SS-385-4A responds to 90% of the measured temperature within 1 sec and to 99% within 3 sec. It uses a standard DIN 100 Ω platinum RTD sensor with a range of -200 to +400°C. The 1/4-in.-diameter sensing tip features a spring-loaded ball joint that rotates 25° in all directions to furnish good surface contact. The probe, excluding handle, is



5 in. long and has a 45° bend near the tip to facilitate contact with hard-to-reach surfaces. \$245. **Casper Integrated Systems**, 541 S Franklin St, Ft Bragg, CA 95437. Phone (707) 964-4109. **Circle No 189**

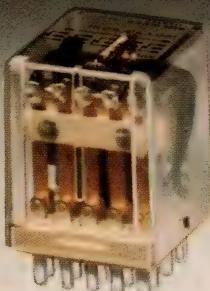
...and other solutions to your tough design problems are found in P&B's growing product line.

AMF
Potter & Brumfield



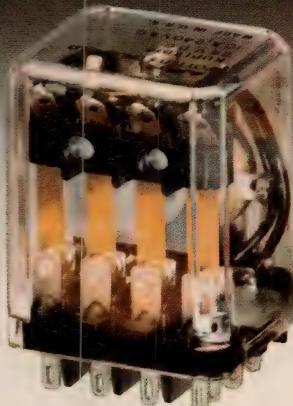
NEW Rocker Actuated Mini-Mag Circuit Breaker. Serves as both panel switch and circuit protector. Trip-free operation. Maximum operating voltage 250V AC or 50V DC. Wide variety of trip curves, ratings from 0.2 to 30 amperes. UL Recognized; CSA Certified.

Circle no 109



NEW 5-Pole KH Relay. 5 form C version of popular KH relay is only slightly larger than present 4 form C model. Rated 3 amps at 30V DC, resistive, or 120V AC. 100,000 operations minimum. Available with plastic dust cover or hermetically sealed in a steel case.

Circle no 110



NEW 4-Pole KU Relay. UL Recognized relay with switching capacity for an additional circuit in the same space as present 3-pole KU. 5 and 10 amp contacts available on both open and enclosed versions. Ideal for use where switching for extra circuits is needed, but additional space is not available.

Circle no 111



NEW K10 General Purpose Relay. Space-saving relay has contacts rated 10 amps at 28V DC or 120V AC, resistive, 100,000 operations minimum. Contact arrangements to 2 form C. Ruggedly constructed for use in alarm systems, control assemblies and other applications requiring 10 amp switching in a limited space.

Circle no 112

New Products



DATA MONITOR. Aimed at field-technician use, Monitor 200 helps diagnose data-communications line problems. Designed to interface with the firm's Encore 100 analyzer, it features ASCII and EBCDIC formats (with hex conversion), 15 speeds ranging from 50 to 9600 baud and either asynchronous or synchronous operation; you can use half- and full-duplex communication modes. Approximately \$5000. **Digitech Data Industries Inc**, 66 Grove St, Ridgefield, CT 06877. Phone (203) 438-3731. **Circle No 190**



LOGIC PROBE. You can use the Model 205 Catch-A-Pulse hand-held unit to analyze and troubleshoot logic gates and sequential circuits such as flip flops, counters, registers and μ Ps. The pen-sized device provides a bright LED display of HIGH, LOW, pulsing or open-circuit logic states (referred to as the unit's truth table) and built-in current limiting. It automatically adjusts to the correct DTL, TTL, MOS, CMOS or μ P circuit thresholds when its leads are connected to the IC-circuit

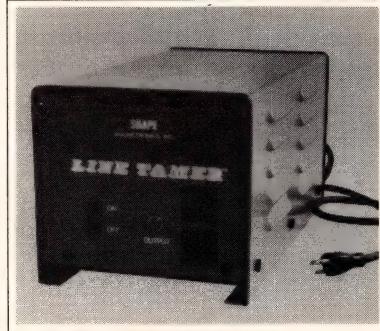
power supply; power-supply reverse-polarity protection is provided. The input impedance of the probe's tip becomes a slave to the circuit under test, causing it to react to whatever signal or logic condition is present; the probe's memory automatically resets every 50 μ sec. \$49.50, including 6-ft coiled cord in clear-plastic carrying case; \$59 for Model 205-K, including high-voltage adapter for 15 to 25V applications. **Triplet Corp**, 1 Triplet Dr, Bluffton, OH 45817. Phone (419) 358-5015. TWX 810-490-2400.

Circle No 191



CLAMP-ON METER. The auto-ranging hand-held Model 2433 measures true-rms voltages, currents and power in single and balanced 3-phase circuits. It uses a patented feedback time-division multiplier circuit to provide accuracies of 1% of reading +0.5% FS. The 243301 version features ranges of 20 to 600V rms, 2 to 200A rms and 2 to 200 kW. Model 243302 features ranges of 20 to 600V rms, 0.2 to 20A rms and 0.2 to 20 kW. Both units furnish an analog output to drive servo recorders. Other features include a Hold switch effective on all ranges and a 3½-digit LCD. \$925. **Yokogawa Corp of America**, 2 Dart Rd, Shenandoah, GA 30265. Phone (404) 253-7000.

Circle No 192



AC-LINE REGULATORS. Line Tamers feature 140-VA to 2-kVA ratings, accept 95 to 130V ac inputs and produce 120V ac ±3%-regulated outputs. The 60-Hz units are UL listed and can maintain output voltages within NEMA specifications with input voltages as low as 65% of rated value. Each model rejects common-mode (120 dB) and transverse-mode (60 dB) noise; interwinding capacitance specs at <0.001 pF. Recovery to within the regulating band takes <25 msec for changes occurring within the rated limits of the regulators. Other features include short-circuit protection and the ability to withstand interruptions to 3 msec while maintaining full output voltage. \$170 to \$852.

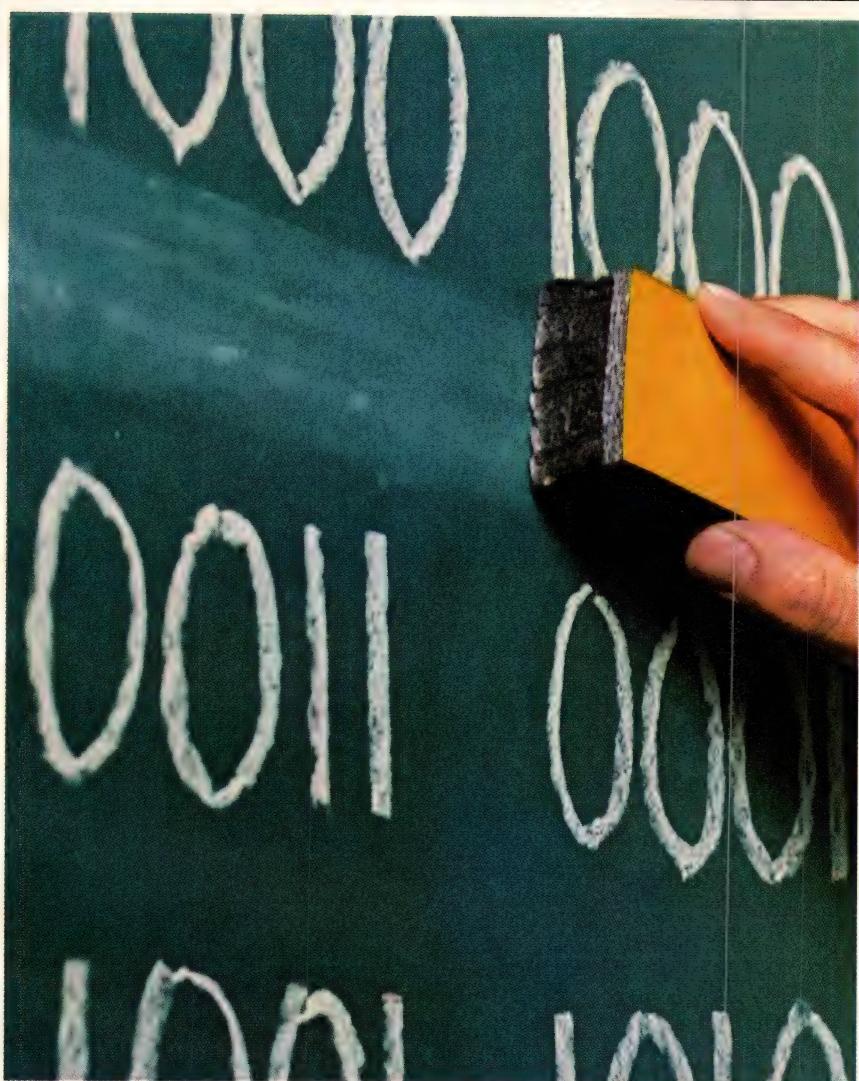
Shape Magnetronics Inc, 901 DuPage Ave, Lombard, IL 60148. Phone (312) 620-8394.

Circle No 193

AC-LINE REGULATORS. Mini-gard Series regulators serve computer, data-terminal and word-processing equipment. The ferroresonant devices feature I/O isolation, 120-dB normal-mode attenuation, 60-dB common-mode noise rejection and operation at a 45-dB sound level. The UL-listed units come in plug-in versions rated to 2 kVA and hardwired models rated from 300 VA to 11 kVA. \$270 to \$3600. **Jefferson Electric**, 840 25th Ave, Bellwood, IL 60104. Phone (800) 323-3293.

Circle No 194

EAROM the word erasable memory.



Whenever you want to record data, retain it, or change it in system...that's when you will want to consider General Instrument EAROM.

Electrically Alterable Read Only Memories give you the application ease of a RAM, the non-volatility of a ROM...plus electrical erasability, word alterability and in-system reprogrammability. That adds up to an unmatched memory capability...enough for you to provide in-circuit programming and reprogramming control without data loss in power outages.

Unlike other non-volatile memory devices, General Instrument EAROMs provide word erasability. This feature permits select changing of data in system without the time consuming need to erase and rewrite everything each time a change is required.

Our EAROMs, available in many configurations, are being used in control, measuring, recording, metering, and tuning applications, to name but a few.

General Instrument has already shipped over 6-million EAROM devices. That's why we say our EAROMs are: A reality for today, rather than a promise for tomorrow.

To learn more about our EAROM family call (516) 733-3107. Or if you wish to discuss applications call (516) 733-3611. Or write Microelectronics Division, General Instrument Corporation, Dept. EM, 600 West John Street, Hicksville, New York 11802.



We help you compete.®

GENERAL
INSTRUMENT

New Products



DATA LOGGER. Series 7240 data-acquisition and control system comprises plug-in function cards for analog and digital signal conditioning plus minidisk-memory and impact-printer options. The IEEE-488-compatible system features BASIC programmability. Standard software permits signal linearization, averaging, multiple alarm limits and data display on the 40-character×24-line CRT. Data tape recorders can independently store programs and data for archival purposes or subsequent statistical analysis; an optional 5½-in. dual 340k-byte flexible-disk memory serves high-speed applications. Optional printers include an 80-column, 150-cps dot-matrix unit. The basic system incorporates a 12-bit A/D converter; plug-in options include an input MUX, digital I/O and pulse-counting functions. \$4200; optional function cards, \$300 to \$400 each. **FI Electronics**, 968 Piner Rd, Santa Rosa, CA 95401. Phone (707) 527-0410. TLX 337769. **Circle No 195**

UNIVERSAL COUNTER. A member of the firm's TM-500 plug-in line, Model DC 509 makes single-shot time-interval measurements with 10-nsec resolution; measurement averaging provides 1-psec resolution. A µP-based reciprocal-counting technique permits frequency measurements to 135 MHz. µP control furnishes autotriggering that senses applied signals and automatically sets trigger levels to their

optimum values. Front-panel jacks permit precise trigger-level adjustment, as well as monitoring of signal-shaping circuits. Other features include an arming input, autoaveraging, probe compensation and a phase-modulated time base that eliminates clock-synchronous errors in time-averaging modes. The standard time base furnishes $<\pm 5 \times 10^{-6}$ FS variation from 0 to 50°C; an optional oven-controlled oscillator improves this figure to $\pm 2 \times 10^{-7}$. \$1500; optional time base, \$275. **Tektronix Inc**, Box 500, Beaverton, OR 97077. Phone (800) 547-1512. **Circle No 196**

DATA-LINE MONITOR. Model 41 line-powered tester monitors an RS-232 interface and indicates whether each of seven signals is a space (3 to 25V), a mark (-3 to -25V) or invalid (-3 to +3V). Seven dedicated LEDs monitor these TD, RD, RTS, CTS, DSR, DCD and DTR signals and indicate mark/space conditions; a bipolar test LED indicates signals >3 V in red and signals <-3 V in green; an OFF indication shows an invalid signal. The unit derives its power from the signals under test. Constant-current LED drivers limit current through each LED to 3 mA. \$99. **Remark International**, 4 Sycamore Dr, Woodbury, NY 11797. Phone (516) 367-3806. **Circle No 197**

POWER CONDITIONER. Providing claimed transient-free, noise-free power for micro/minicomputer systems and preventing mutual interference between as many as 12 different EDP devices within a system, the Voltector Series 7 Model R150 ac power conditioner/distribution center is said to



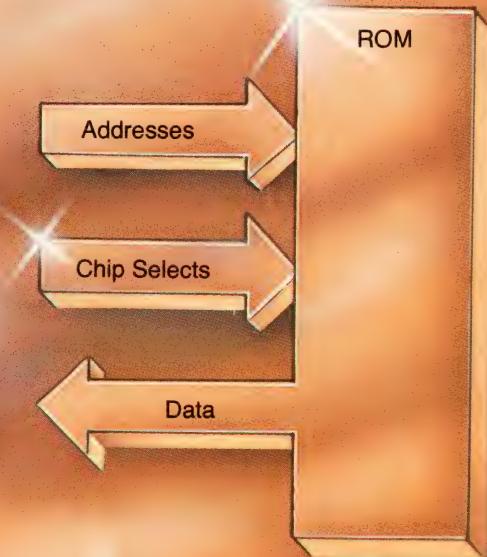
protect EDP equipment against induced lightning effects, inductive-load switching transients, ac-power-line RFI and EMI in both differential and common modes. The relay-rack-mounting device includes a 15A bidirectional Comtrans filter, circuit-breaker On/Off switch, elapsed-time meter and eight, 10 or 12 independently RF-isolated ac receptacles. \$448 (eight outlets) to \$497 (12 outlets). **Pilgrim Electric Co**, 29 Cain Dr, Plainview, NY 11803. Phone (516) 420-8989. **Circle No 198**

TEMPERATURE-TEST SYSTEM. The µP-controlled 8-kHz to 60-MHz Model 2001 permits the series and load-resonant testing of 78 quartz crystals simultaneously without operator intervention during the test run and provides GO/NO-GO indication against user-keyed-in elements. It records up to 60 temperature points between -55 and +150°C. Temperature accuracy equals $\pm 0.15^\circ\text{C}$ anywhere in the test chamber. A typical test run of 78 crystals tested at 5°C intervals from -40 to +85°C requires <1.1 min per crystal. Standard systems print out complete measurements for failed units as those measurements are made, along with a summary of failures at the end of the test run. \$13,000 to \$18,000. Delivery, 90 days ARO. **Saunders & Associates Inc**, 7440 E Karen Dr, Scottsdale, AZ 85260. Phone (602) 991-9250. TWX 910-950-0087. **Circle No 199**

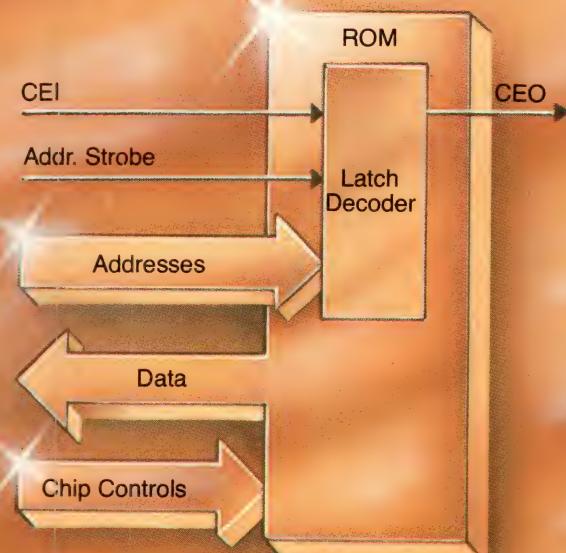
Hughes Offers More ROMs (4, 8, 16K)... with Less Power Consumption.

CMOS ROMs

Industry Standard Pinouts



1802 CPU Compatible Pinouts



Hughes Part Number	Industry Standard Pinouts	ROM Organization
1832	2704	512x8
1834	2708	1024x8
1836	2716	2048x8

Hughes Part Number	ROM Organization
1831	512x8
1833	1024x8
1835	2048x8

HUGHES

HUGHES AIRCRAFT COMPANY

Solid State Products
10 Superior Avenue
Newport Beach, CA 92663
(0) 854-3515 or
(14) 759-2942

Europe
Hughes Microelectronics Ltd.
One House
2-18 Queens Road
Surrey, KT 139XD
England
Telephone 932-47262

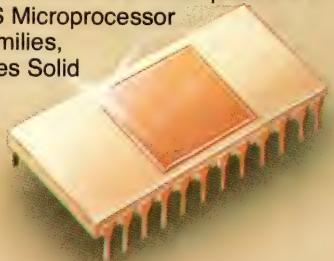
Hughes delivers more of what you're looking for in low-power CMOS memory devices, including static masked ROMs and RAMs (no clock or strobe), very low operating and standby power dissipation (typically 1/40th of NMOS memories), high noise immunity and wide tolerances to voltage and temperature variance.

Hughes 16K CMOS ROMs are available in two versions: the HCMP 1836 which is a pin-for-pin replacement for industry-standard N-channel PROMs or ROMs, and the HCMP 1835 which is 1802-compatible. 4K and 8K units are also available. Hughes offers fast ROM turnaround to prototype and production units.

Hughes also delivers CMOS RAMs which are organized 32x8 for small-storage applications or 256x4 (compatible with the industry standard 5101) for larger requirements.

All Hughes CMOS memories are available in economical plastic or standard ceramic packages in high (4-12v) or low (4-6.5v) voltage ranges and in commercial or military (883 tested) versions.

For information about these and other products in the Hughes CMOS Microprocessor and LCD Driver families, call or write: Hughes Solid State Products.





32 to 64

Channels...with a Battery

Dolch Logic Instruments' third generation logic analyzer, the LAM 3250, lets you meet your troubleshooting needs now, and expand for the future. The LAM 3250 records up to 32 channels of information at sampling rates to 50 MHz, and with optional Channel Expansion Probes, its capability can be extended to 64 channels. And there's more.

Sophisticated clocking.

Since it incorporates dual 16-channel X 1000-bit recording blocks, the LAM 3250 can accept up to two independent external clocks for sampling data, letting you independently monitor both address and data on a multiplexed bus.

Powerful triggering.

Four-level sequential triggering, each level with an independent pass counter ranging from 1-255 counts, lets you debug programs containing nested subroutines. There's even a Restart function to guide you through data on the bus. All of this is easily programmed in a separate trigger menu.

Battery back-up.

The LAM 3250's revolutionary new BATTERY-BACKED MENU MEMORY feature allows you to store up to 6 separate files of display and menu parameters in CMOS RAM for up to three months without power. This means that

you can recall complete test set-ups in a matter of seconds. No more time wasted rewriting menus.

Check these features and compare:

- 32 channels X 1000-bit memory
- Expandable to 64-channel X 500-bit memory (optional)
- Sampling rates to 50 MHz
- 5 ns glitch capture
- Timing capability for 16 or 32 channels
- Hex, octal, binary and ASCII displays
- Powerful word search feature
- Window triggering
- Real-time trigger tracing
- Non-volatile menu memory
- GPIB and RS-232 interfaces standard
- Personality probes and disassemblers for many popular uP's and bus systems (optional)

This is only part of the story. For more details on this and other dynamic troubleshooting tools, contact the logic analyzer experts today. Dolch Logic Instruments, 230 Devon Drive, San Jose, CA 95112. Or call toll free (800) 538-7506. In California (408) 946-6044.

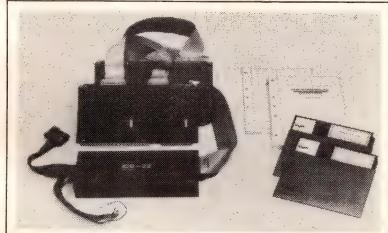


DOLCH
LOGIC INSTRUMENTS

Circle no. 107 for more information
Circle no. 114 for demonstration

New Products

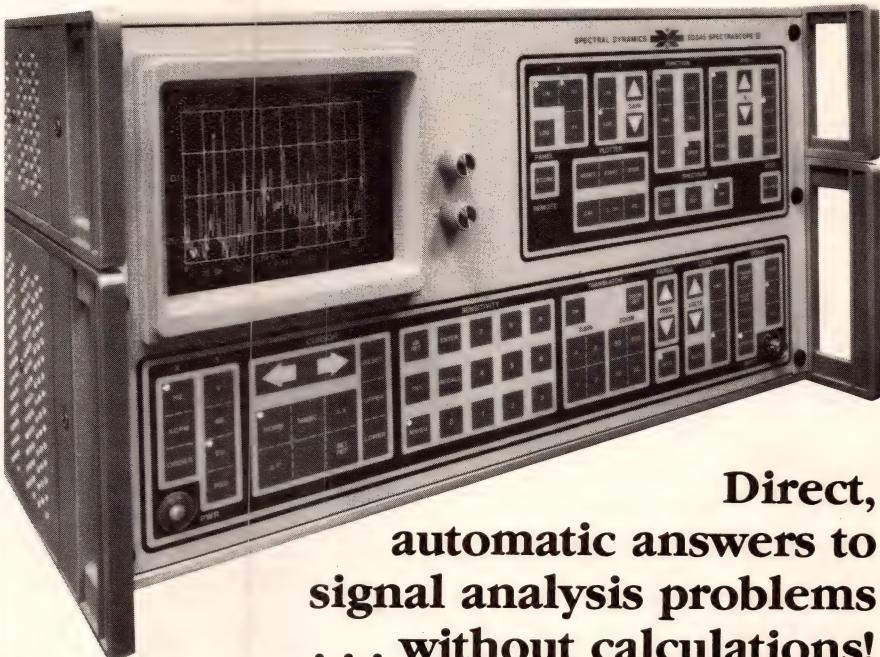
ERROR MEASUREMENT. For the production testing, field installation and maintenance of Bell digital transmission systems, Model 3781B μ P-controlled pattern generator and Model 3782B error detector provide a real-time clock and HP-IB printer output and interface at DS-1, DS-1C, DS-2 and DS-3 levels in the digital hierarchy. Ternary coding and interface-voltage levels at each hierarchical level are selected automatically. Alternatively, binary ECL interfaces can be used at bit rates from 1k to 50M bps. Three pseudorandom binary sequences, six fixed word patterns and a jitter-modulation input facility with peak-to-peak jitter LED readout are also furnished. Binary, code or parity errors can be measured and displayed over a wide range of gating periods. Model 3781B, \$7340; Model 3782B, \$6895. Delivery, 8 wks ARO. **Hewlett-Packard Co.**, 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office. **Circle No 200**



IN-CIRCUIT EMULATOR. For use with Intellec development systems and emulating the 8022 μ C at clock rates from 0.6 to 3.6 MHz, Model ICE-22 uses a bond-out version of the 8022 chip, a configuration with on-chip bus lines accessed through additional lead bonds. Programs can be altered directly through the unit using assembler mnemonics, and 8022 characteristics, such as drive, load and timing in real-time operation, are not masked by intervening

devices. A high-speed 2k-byte RAM that emulates on-chip ROM is provided in the emulator buffer box. Also featured are a single-line assembler, allowing the alteration of memory using assembly-language mnemonics with a simple emulation command, a HELP file providing

command syntax information on the console display screen and a 500-instruction-cycle trace memory with trace-qualifier register. \$5950. Delivery, 4 to 8 wks ARO. **Intel Corp.**, 5200 NE Elam Young Parkway, Hillsboro, OR 97123. Phone (503) 640-7792. **Circle No 201**



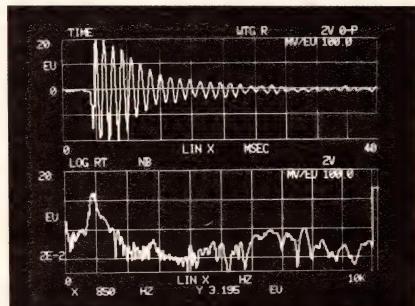
Direct, automatic answers to signal analysis problems . . . without calculations!

Confused by having to convert dB reference numbers to meaningful engineering unit (EU) values you can understand? The SD345 FFT Signal Analyzer does it automatically and displays the correct numbers instantly and directly on an exceptionally clear raster-scan display. Or you can record the answers by photography, digital or analog plotter, or video hard copy.

But getting instant, automatic solutions to your problems is only the first-order reason you should own the SD345. Our new 12-page brochure outlines its many other exclusive capabilities and applications. The SD345 is today's best buy . . . it's available right now . . . and we'll be glad to stage a live demonstration in your lab.

Call Leon Corcoran at (714) 268-7197 to schedule your demo.

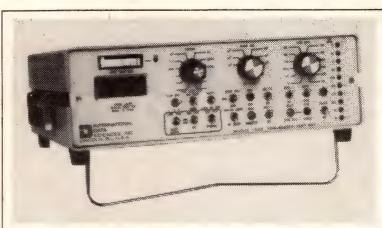
Actual photo of raster scan display — flicker-free, with full grids, complete annotation and engineering-unit readouts for total answers, understandable and usable at a glance. An incoming time waveform can be displayed simultaneously with a spectrum analysis of that waveform (on a real time or averaged basis) for direct comparison.



Spectral Dynamics
Scientific-Atlanta

P.O. Box 671 • San Diego, CA 92112 • (714) 268-7100 • TWX 910-335-2022
For more information, Circle No 71

New Products



BER TEST SET. Model 1320 is a portable self-contained unit designed to analyze the error rate of any digital transmission network. It can be used to test synchronous, asynchronous or start/stop character-oriented systems, including time-division multiplexers. Bit, character and block error rates are determined by transmitting pseudorandom test patterns over the communications channel to accurately simulate computer-generated data. A start/stop character can be programmed and transmitted in either a single or continuous format; the unit can also generate special repeating sequences of ASCII or other characters. \$3950. Delivery, 60 days ARO. **International Data Sciences Inc.**, 7 Wellington Rd, Lincoln, RI 02865. Phone (401) 333-6200. TWX 710-384-1911.

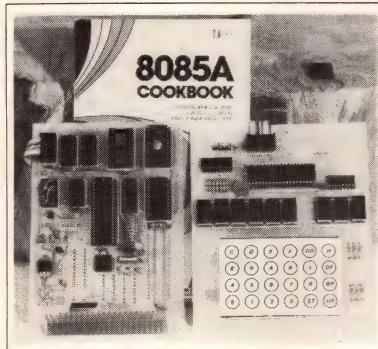
Circle No 202



LOGIC - TRIGGER PROBE. Adding 16 channels to the triggering capacity of the company's data test equipment, the 20-MHz 9×4.3×8.3-in. PM 8810 can perform synchronous or asynchronous and parallel or sequential triggering. In Synchronous triggering mode, trigger output occurs when trigger

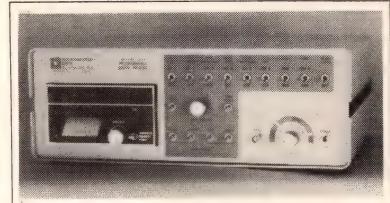
word and clock qualifiers are true with respect to an active clock edge. In Asynchronous mode, trigger output occurs as soon as trigger word and clock qualifiers are true. Parallel triggering can be accomplished in either a Continuous or Latched mode. Setup time specs at ≤ 30 nsec. Maximum input voltage ranges from -50 to +50V. \$1800. Delivery, 60 days ARO. **Philips Test & Measuring Instruments Inc.**, 85 McKee Dr, Mahwah, NJ 07430. Phone (800) 631-7172; in NJ, (201) 529-3800.

Circle No 203



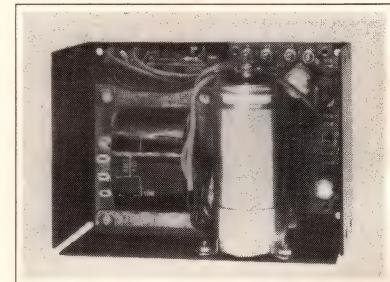
μ P TRAINING UNIT. Model 8085AAT MTU includes a tested and assembled 8085A μ C with 1k of RAM, 1k of PROM, 1k of EPROM, programmable I/O, keyboard unit, CPU card and a display and operating system. Also provided are a 44-pin edge connector, area on the CPU card for custom wire-wrapping design or user-defined interface circuitry and a 20-mA asynchronous port. Software includes a step-by-step instruction manual, user's manual with programs, a 352-pg 8085A cookbook covering μ P concepts through design stages and a 334-pg 8080/8085 software design book with >190 executable program examples. \$299.95; kit version, \$249.95. **Paccom**, 14905 NE 40th St, Redmond, WA 98052. Phone (206) 883-9200. TWX 910-449-2592.

Circle No 204



DIGITAL PRINTER. Initiated at preselectable time intervals to detect transitions in critical data-interface signals, printouts from Model 2010 record the time an event occurred, a channel identifier and three digits of bit, block or character errors. Features of the programmable thermal unit include a presettable real-time clock, six selectable trigger channels and seven selectable print periods. For paper reloading, the printer mechanism is removable from the device's front panel. The unit operates with any of the company's modem test sets. \$3650. **International Data Sciences Inc.**, 7 Wellington Rd, Lincoln, RI 02865. Phone (401) 333-6200. TWX 710-384-1911.

Circle No 205



OPEN-FRAME SUPPLY. Offering a variety of voltage and current outputs ranging from 5V/9A to 48V/1.5A, Model SOLV45 provides line and load regulation of 0.1% and a temperature range of 0 to 55°C. Overvoltage protection is optional for the 4.88×7×2.88-in. unit. \$52 (250). **Elpac Power Systems**, 3131 S Standard Ave, Santa Ana, CA 92705. Phone (714) 979-4440. TWX 910-595-1513.

Circle No 206

Introducing high performance storage for any micro. Ready to roll.



Digital's new TU58-EA will change the way you use tape storage.

Because it combines the convenience

and cost advantages of a ready-to-roll tape

cartridge, with the performance advan-

tages of random accessing.

The TU58-EA is a compact table-top package, complete with power supply and EIA interface, ready to hook up to any computer.

And it has a built-in MPU that makes it think like a disk. Instead of handling data serially like other tape systems, the TU58-EA reads, writes and searches for data in blocks. So you can use it in more time-critical applications.

We also offer two unpackaged versions for greater design flexibility: the single-drive TU58-AB, and dual-drive TU58-BB. Both offer universal EIA interfacing.

High performance storage is just one of the ways Digital makes microcomputers easier to work with. We offer hundreds of hardware products to choose from. Boards,

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Ltd. Or contact your local Hamilton/Avnet distributor.

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New Products



TEST SYSTEM. You can test most 4- to 12-bit bipolar or MOS monolithic or hybrid A/D or D/A converters with the Model 1731's family board without writing elaborate programs. Exchanging the plug-in family boards and tape cartridges containing the 48k RAM-based

operating software allows comparator/regulator testing. Parameters measured include gain error (%), zero error (% FS), linearity error (% FS), differential linearity (% FS), power-supply specs, rejection ratio and accuracy of the DUT's internal voltage reference. Current-force and voltage measurement capabilities permit dc parametric measurements on digital-I/O pins. Front-panel pass/fail indicators, manual and automatic binning and summary results on an integral 5-in. CRT are also provided. From \$32,500, including program library, and ADC/DAC family board. Delivery, 12 to 14 wks ARO. **GenRad Inc**, 300 Baker Ave, Concord, MA 01742. Phone (617) 369-4400.

Circle No 207

**THE GRALEX MODEL 30
OUTSHINES THEM ALL**



**ONLY the Gralex high quality, low cost*
Model 30 DPM offers you ALL these features:**

SHORT DEPTH

Only 3/4" deep. Easy to install. Won't interfere with internal components.

LOW POWER

1 Watt @ 5Vdc.

HIGH PERFORMANCE

Model 30 DPM meets or exceeds specifications of higher priced models.

QUICK DELIVERY

Gralex worldwide distributors have DPMs in stock for off-the-shelf delivery.

AND MORE

First meter to list pinouts on the case. Connectors always included. Available as a board only (Model 31).

*OEM: under \$38 - one piece: \$48.50

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Call or write today for more information and the name of our nearest representative or distributor.

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For more information, Circle No 73

DC AMPLIFIER. Model 13-4615-20 high-gain unit has a maximum sensitivity of 50 μ V FS, a measurement range of 50 μ V to 250V FS, claimed low output noise and good zero line stability and calibrated zero suppression for examination of complex waveforms. A solid-state input chopper is included, and an internal master/slave switch allows two or more amplifiers to be operated at maximum sensitivity within the same physical environment. Calibrated zero suppression provides 12 switch-selectable full-scale ranges of +100, +10, +1, -1, -10 and -100 mV or V. A calibrated reading with a resolution of 1 part per thousand is provided on each full-scale range. Other features include differential fully floating isolated input; 5-position low-pass output filter and >160 dB (at dc) and 140 dB (at 60 Hz) CMR. \$990. **Gould Inc**, 3631 Perkins Ave, Cleveland, OH 44114. Phone (216) 361-3315. Circle No 208

308 DATA ANALYZER

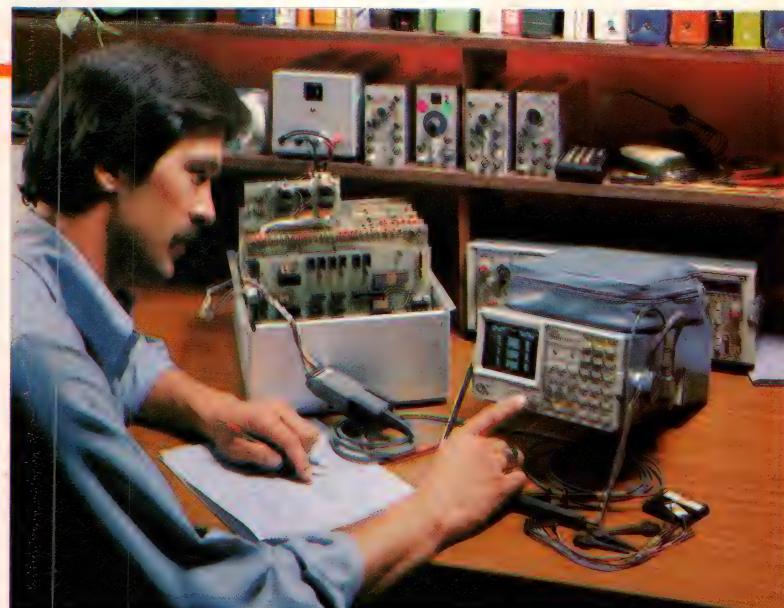
Big power in a small package.

The 308 operates in four modes: parallel state, parallel timing, serial state and signature analysis.

The 308 Data Analyzer. From Tektronix.

The new 308 Data Analyzer packs an impressive array of logic analysis capabilities inside its trim, 8 pound (3.6 kg) frame. For instance, it operates in the serial and signature modes as well as parallel state and timing. And samples both synchronously and asynchronously up to 20 MHz. With a variable voltage threshold that covers all logic families in addition to TTL.

Two separate memories, acquisition and reference, allow automatic data comparisons. If there's no data difference, the sampling process is repeated until a discrepancy appears. And the acquisition memory can be automatically searched for any given word.



Word recognition can be up to 25 bits and includes an external output to trigger other instruments. And the trigger itself can be delayed up to 65,535 clock pulses past the trigger point. The 308 features a latch mode (5 ns), a memory "window" to let you closely examine portions of the memory and state tables which are displayed in binary, hex and octal.

The 308 Data Analyzer, from Tektronix. Performance? Uniquely versatile. Size? Conveniently compact. Price? Exceptionally reasonable.

If you're interested, contact your local Tektronix field office, or write us at:

U.S.A.
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P.O. Box 1700
Beaverton, OR 97075
Phone: 503/644-0161
Telex: 910-467-8708
Cable: TEKTRONIX

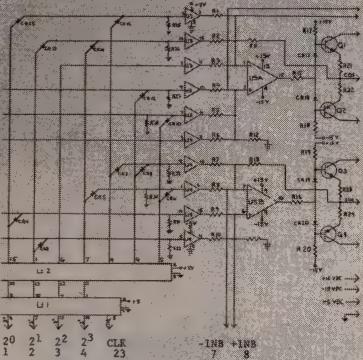
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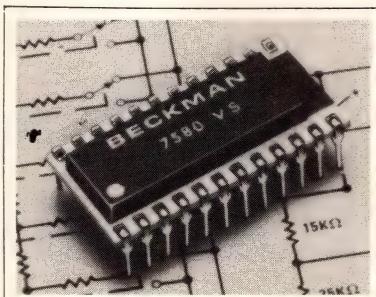
TELEDYNE CRYSTALONICS

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Cambridge, MA 02140
Tel: (617) 491-1670
TWX 710-320-1196

For more information, Circle No 74

New Products

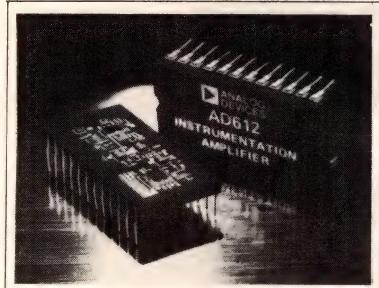
ICs & SEMI-CONDUCTORS



12-BIT DAC. Model 7580VS sports a conversion time of 6 μ sec and includes a voltage reference, output op amp, TTL/CMOS level translators, CMOS switches and a thin-film R2R ladder network. Five programmable ranges are provided: three bipolar ranges of -2.5 to +2.5, -5 to +5 and -10 to +10V and two unipolar ranges of 0 to 5 and 0 to 10V. Nonlinearity specs at $\pm 0.0125\%$ max, $\pm 0.00635\%$ ($\pm 1/4$ LSB) typ, and the unit is pin compatible with the DAC 80. Operating temperature ranges from 0 to 70°C. Approximately \$22 (OEM qty) in ceramic double DIP. **Beckman Instruments Inc**, 2500 Harbor Blvd, Fullerton, CA 92634. Phone (714) 773-8800. **Circle No 234**

BAND-SPLIT FILTER. A dual-tone multiple-frequency CMOS switched-capacitor device for tone-dialing equipment, Model S3525 comes in two versions: One produces a 3.58-MHz buffered oscillator signal; the other, an 894.89-kHz square-wave signal. Operating with tone-decoder chips from Teletone, Rockwell, Mitel and Mostek, the unit uses a standard 3.58-MHz TV crystal with the on-chip oscillator and frequency dividers, provides 52-dB min rejection in the 300- to 500-Hz band and furnishes dc open-loop gain of 80 dB typ and 60-dB typ CMR

for the op amps. Overall gain equals 6 dB for both high- and low-group signals with 40 dB of opposite-group rejection. The squaring function is handled by on-chip comparators, externally programmed for sensitivity. \$14.50 (100) in 18-pin plastic packages. **American Microsystems Inc**, 3800 Homestead Rd, Santa Clara, CA 95051. Phone (408) 246-0330. **Circle No 235**



INSTRUMENTATION AMPS. These pin-programmable hybrid units permit user selection of either optimized dc performance with good dynamic characteristics or optimized dynamic performance with good dc characteristics. The AD612 provides a guaranteed input offset-voltage drift as low as $\pm 1 \mu V/C$ max (C grade) and a small-signal bandwidth (-3 dB) of 60 kHz. Model AD614 features a bandwidth of 160 kHz and 30- μ sec max settling time to $\pm 0.01\%$ at a gain of 128V/V. Both devices also furnish a pin-programmable gain range of 1 to 1024V/V, $\pm 0.001\%$ nonlinearity and a guaranteed gain TC of ± 10 ppm/ $^{\circ}$ C max. Input-voltage noise for both models specs at 2 μ V rms in a 10-Hz to 10-kHz bandwidth; guaranteed CMR equals 74 dB min at a gain of 1V/V and 94 dB min at a gain of 1024V/V. AD612, \$40 to \$52; AD614, \$49.50 to \$61 (100) in 24-pin ceramic DIPs. **Analog Devices Inc**, Box 280, Norwood, MA 02062. Phone (617) 329-4700. **Circle No 236**

Microcontrol Mastery with Signetics 8X300

Compact floppy disk controller handles multiple drives and formats.

How one design met several goals in firmware.

Today's floppy disk controllers need more than high-performance interface capability. That's why the goals for this design were to maximize flexibility and minimize board space. With performance for tomorrow's needs.

This design—a programmable, intelligent I/O controller built around the 8X300 microcontroller and the 8X330, a new floppy disk controller chip—achieves these goals.

Flexibility is achieved because this FDC can handle multiple disk drives in any combination of single/double density on 5½ or 8 inch media. With either standard or non-standard track formats.

The on-board 8X300 microcontroller minimizes host overhead by implementing user-defined macro commands. Designed-in flexibility also allows error correction within IBM-compatible formats. And, bipolar performance meets next generation drive requirements with 1 megabyte/second data transfer rates.



Compact Floppy Disk Controller occupies less than half of a standard 7"x12" PCB. The complete controller, based on Signetics' 8X330/8X300, consists of only 10 chips and a host interface.

The 8X330 is the first floppy disk controller chip to integrate the PLL data separator and write precompensation. Result: board space is minimized. An entire double-sided, double-density, dual drive disk controller with RS232 interface requires less than 30 square inches.

Greater flexibility, smaller size, and lower cost. All made possible by the 8X300 microcontroller and the new 8X330 floppy disk controller from Signetics. Find out how you can put Signetics' Microcontrol Mastery to work in your system. Write us today. Or call any Signetics sales or distributor office. *Signetics Corporation, 811 E. Arques Ave., P.O. Box 409, Sunnyvale, CA 94086. (408) 739-7700.*

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- Please send technical information on the
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Bipolar LSI specialist contact me today at:
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Company _____ Division _____

Address _____ MS _____

City _____ State _____ Zip _____

EDN 120

What can you honestly expect from an interactive data terminal that costs as little as \$255 O.E.M.?*



Well, to begin with, color graphics.

RCA's VP-3301 has unique color-locking circuitry that gives you sharp, jitter-free color graphics and rainbow-free characters.

Plus much more: Microprocessor control. Resident and programmable character set. Reverse video. State-of-the-art LSI video control. 20 and 40 character formats. RS232C and 20 mA current loop. Six baud rates. Eight data formats. ASCII encoding. Light-touch flexible-membrane key switches for reliability and long life. CMOS circuitry and a spill-proof, dust-proof keyboard for hostile environments.

The VP-3301 can be used with a 525-line color or monochrome monitor or a standard TV set through an RF modulator. It serves a wide variety of industrial, educational, business and individual applications including communication with time sharing and data base networks.

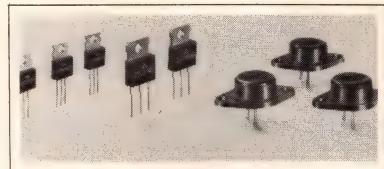
All this—for as little as \$255. And it's made by RCA. So get the whole story about the surprising VP-3301 today. Write RCA MicroComputer Marketing, New Holland Avenue, Lancaster, PA 17604. Or call toll-free: 800-233-0094.

* Quantity price. Monitor and modem not included.
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For more information, Circle No 97

New Products



SWITCHING TRANSISTORS.

Housed in metal TO-3 and plastic TO-220AB and TOP-3 packages, these high-voltage medium-power devices offer collector-to-emitter voltages to 500V and maximum power dissipation (at 25°C) to 100W. Collector currents range from 3 to 20A, leakage currents (I_{CBO} and I_{EBO}) spec at 100 μ A, cutoff frequencies run to 3.5 MHz and maximum t_f equals 1 to 1.2 μ sec. Collector-to-emitter saturation voltages ($V_{CE(sat)}$) are 1 to 1.5V. The units can be operated at high ambient temperatures when junction temperature doesn't exceed 150°C. From \$0.97 (1000). Delivery, stock to 12 weeks ARO. **Panasonic Co**, 1 Panasonic Way, Secaucus, NJ 07094. Phone (201) 348-7842.

Circle No 237

CMOS DIVIDER. For generating decade-related time bases, the 8-pin mini-DIP RDD104 addressable unit divides by 10, 100, 1000 or 10,000. Features of the monolithic device include an active oscillator network on one input controllable by an external crystal or frequency source, an input-shaping network that accepts sine- or square-wave inputs and input clamp diodes that accept overvoltage signals with the aid of a current-limiting resistor. A square-wave output and reset are also provided. Operating-voltage range spans 4.75 to 15V; operating temperature, -40 to +85°C. \$1.55 (1000). **LSI Computer Systems Inc**, 1235 Walt Whitman Rd, Melville, NY 11747. Phone (516) 271-0400. TWX 510-226-7833.

Circle No 238

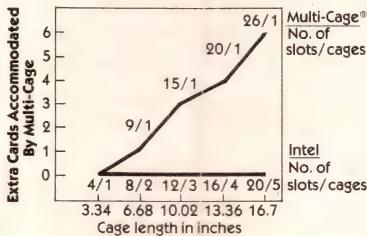
More Room... More Multibus® Cages.



ONLY FROM ELECTRONIC SOLUTIONS!

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You get more room for extra cards without increasing overall size, because our design gives you greater inside dimensions.

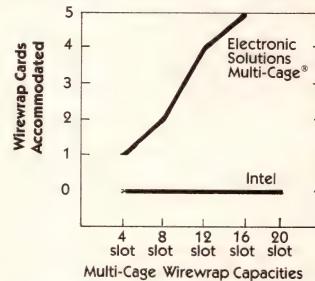


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All cages are constructed of sturdy, durable anodized aluminum with a single mother board backplane . . . a concept that increases reliability and minimizes interconnections.

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We have more models than all our competitors combined. Choose a cage with 3, 4, 5, 6, 7, 8, 9, 12, 14, 15, 16, 20, 24 or 26 slots for the right solution to your problem. We have models with either 0.6" or 0.75" card centers and can even accommodate wirewrap cards



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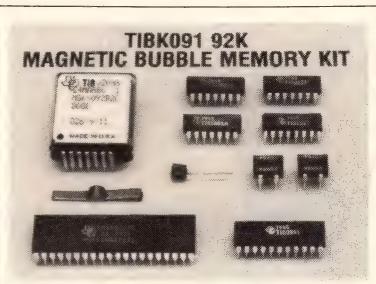
MULTI-CAGE®

For more information, Circle No 77

New Products

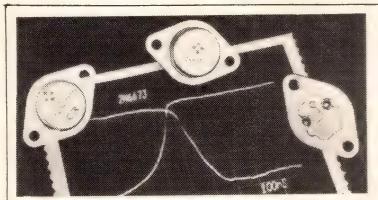


SCHOTTKYS. 30A devices intended for center-tap rectification and for use in medium-power switching supplies, MBR3020CT / 3035CT / 3045CT and SD241 full-wave bridges combine two chips in one TO-3 package. The 20, 35 and 45V units provide an operating junction temperature of 150°C with reverse voltages to 45V. The two dies can be used in parallel, and a built-in guard ring reduces junction stress and operates like a zener for transient protection. 0.45-in. pins and cathode-to-case polarity are standard. MBR3020CT, \$5.70; MBR3035CT, \$6.35; MBR-3045CT, \$7; SD241, \$6.70 (100). **Motorola Semiconductor Products Inc**, Box 20912, Phoenix, AZ 85036. Phone (602) 244-4624. **Circle No 239**

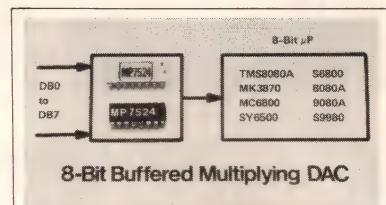


BUBBLE-MEMORY KITS. The TIBK091 kit, containing the parts required to construct a minimum memory system, furnishes one 50k-bps TIB0203S 92k-bit bubble memory, a TIB0833 sense amplifier, two TIB0801A coil drivers, a TIB0861 function driver, two VSB53 diode arrays, a TSP102G thermistor, a TIB0951 function-timing generator and a TIB0901 controller. The

TIBK090 kit contains all the parts needed to construct a modular memory unit (MMU) and provides all TIBK091-kit parts except the function-timing generator and controllers. Because each function-timing generator and controller pair can drive as many as 10 modular memory units, each containing one bubble memory, the TIBK091 kit's memory capacity can be expanded by using multiple TIBK090 kits utilizing the same timing generator and controllers. TIBK090 \$151; TIBK091, \$191. **Texas Instruments Inc**, Box 225012, M/S 308, Dallas, TX 75265. Phone local office. **Circle No 240**



SWITCHING TRANSISTORS. High-speed, high-voltage units meeting JEDEC specifications, Models 2N6671, -6672 and -6673 feature V_{CEO} s of 300, 350 and 400V, respectively, and an 8A continuous collector current. Peak collector current is rated at 10A; maximum collector saturation voltage, 1V. Switching speed for all three models specs at 2.5 μ sec storage with 0.4- μ sec fall time. Minimum gain-bandwidth product equals 15 MHz. The npn devices dissipate 150W and feature an extended turn-off safe operating area, allowing them to switch inductive loads at 5A into the rated voltage without snubbing. 2N6671, \$3.18; 2N6672, \$3.60; 2N6673, \$4 (100) in TO-204MA cases. Delivery, stock to 8 wks ARO. **General Semiconductor Industries Inc**, Box 3078, Tempe, AZ 85281. Phone (602) 968-3101. **Circle No 241**

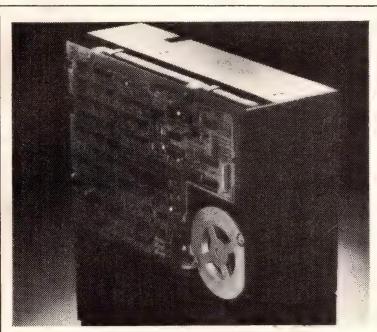


MULTIPLYING DAC. Replacing the AD7524, the 8-bit monolithic CMOS MP7524 provides accuracy to $\pm 1/8$ LSB with a power dissipation of 10 mW. Other specs of the buffered unit include accuracy of $\pm 0.05\%$, gain TC of 10 ppm and settling time of 100 nsec. The device is available in three temperature ranges, with 883B processing, in die form or to customer specs. \$4.40 (100) for typical 16-pin plastic unit. **Micro Power Systems Inc**, 3100 Alfred St, Santa Clara, CA 95050. Phone (408) 247-5350. TLX 910-338-0154. **Circle No 242**

PREAMPLIFIER. For automotive and other low-noise applications, Model LM1897 stereo-tape-deck preamplifier reduces both the size and number of required external components and eliminates all but the minimum number of external capacitors, thus reducing pc-board space. The tape head connects directly to the IC, eliminating the usual input coupling capacitor and resulting in input noise voltage of 0.6 μ V CCIR/ARM. The device uses a 2-amplifier approach to deliver 76 dB at 20 kHz open-loop gain. Operating with any supply voltage from 4 to 18V, the unit provides 105-dB ripple rejection and turns on without a pop after a programmable delay time. <\$0.85 (OEM qty). Delivery, 6 to 8 wks ARO. **National Semiconductor Corp**, 2900 Semiconductor Dr, Santa Clara, CA 95051. Phone (408) 737-5000. TWX/910-339-9240. **Circle No 243**

New Products

COMPUTERS & PERIPHERALS



HARD-DISK DRIVES. The Q2000 series of 8-in. hard-disk drives includes the 10.67M-byte (unformatted) single-disk Q2010, the 21.33M-byte 2-disk Q2020 and the 32M-byte 3-disk Q2030. Key features include 4.34M-bps transfer rate, 10-msec average latency and 100-msec max track-to-track access time.

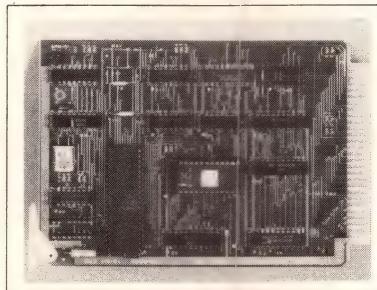
In addition to Shugart Associates SA1000 format and interface compatibility, the drives furnish 6600-bpi max recording density, 6600-fci max flux density, 345-tpi track density and 3000-rpm rotational speed. With the recommended 256-byte 32-soft-sector format, formatted capacities total 8.4M bytes (Q2010), 16.8M bytes (Q2020) and 25.2M bytes (Q2030).

The series comes with compatible controllers, exercisers and data separators. \$1200 for the Q2010, \$1500 for the Q2020 and \$1800 (500) for the Q2030. Delivery, 30 to 60 days ARO. **Quantum Corp.**, 2150 Bering Dr., San Jose, CA 95131. Phone (408) 262-1100.

Circle No 244

PAPER-TAPE READER. Model FER-204 features fiber-optic technology and a maximum synchronous bidirectional reading speed of 300 cps. Accepting CMOS, TTL or open-collector

logic inputs, it consumes approximately 26W operating and 12W idle with a 24V dc supply, reads 6- or 8-track paper tapes with transparencies up to 60% and conforms to DIN 66014, ECMA-10, ISO R1154-1969 and BS 3380 American and European standards. \$415. Manufactured by Ghielmetti Ltd of Switzerland and available from **Sutherland & Associates Inc.**, 6290 Sunset Blvd, Suite 1126, Los Angeles, CA 90028. Phone (213) 463-5090. TWX 910-321-2903. **Circle No 245**



16-BIT CPU. The DM-8800 μP board uses an 8088 μP to provide STD Bus systems with 16-bit processing and 1M-byte addressing. Totally software compatible with the 8086, the 5-MHz unit performs a 16×16 multiply in 25 μsec—a 30-fold improvement over 8085 performance. Other features include a 5V supply and an on-board EPROM (either a 2716, 2732 or 2764) for 2k, 4k or 8k memory bytes. The EPROM is decoded at the top of the megabyte address space, leaving the first 64k bytes free for off-board memory. A software debugging monitor is available in EPROM for stand-alone use, allowing programs to download from Intel- or CP/M-based development systems into RAM. \$395; debugging monitor, \$195. **Desert Microsystems Inc.**, Box 1174-D, Pasco, WA 99301. Phone (509) 547-3397.

Circle No 246



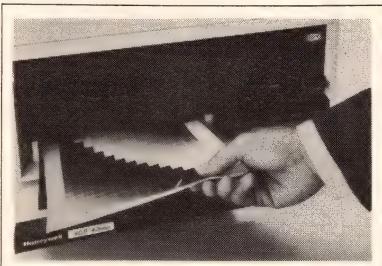
MODEM. Two modems in one, the ACM300/1200 can operate as either a 0 to 300-bps asynchronous full-duplex unit or as a 0 to 1200-bps asynchronous half-duplex device. It transfers low- or medium-speed data over normal-voice grade lines using available telephone handsets, a front-panel switch-selectable feature that needs no adjustment of straps, cables or cards. The handset-coupling design provides positive mechanical locking and noise isolation. The modem comes in an impact-resistant case that suits portable or desktop use. \$695. **Rixon Inc.**, 2120 Industrial Parkway, Silver Spring, MD 20904. Phone (301) 622-2121.

Circle No 247

DISK DRIVES. TM 600 Series 5½-in. mini-Winchester units offer unformatted storage capacities ranging from 3.19M to 11.5M bytes. Available in 1-, 2- and 3-platter versions, the drives feature 3-msec track-to-track access time. Average access time specs at 168 msec, including head-settling time (245 msec in the extended-cylinder version). Other specs include 7690-bpi recording density and 3600-rpm rotational speed. Daisy chaining as many as four TM 600s provides up to 46M bytes of on-line storage (unformatted). \$1400 to \$1600. **Tandon Magnetics Corp.**, 9333 Oso Ave, Chatsworth, CA 91311. Phone (213) 993-6644.

Circle No 248

New Products



HARD COPIER. Model VGR 4000 records the displayed image of a broad range of video displays. Warming up in <5 min, it produces 8½×11-in. high-resolution pictures on dry silver paper from most raster-scan units, within 14 sec and in as many as 16 shades of gray. Desktop or rack mountable, the unit features built-in test and diagnostic functions, optional 4-channel multiplex capability, copy counter, platenless operation and (on standby) 100W

power consumption. \$5000 to \$7000. **Honeywell Test Instruments Div.**, Box 5227, Denver, CO 80217. Phone (303) 771-4700.

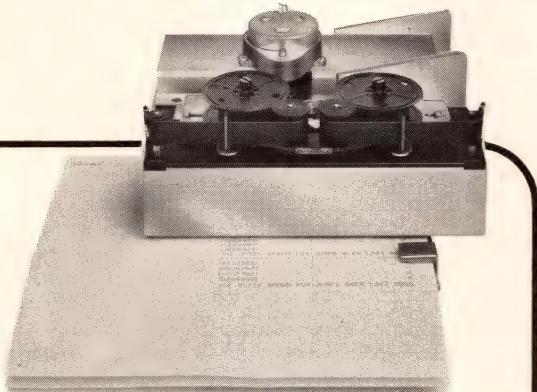
Circle No 249

ASSEMBLERS. M68 for Motorola's 6800 µC and M18 for RCA's 1802 computer are relocatable assemblers that run on CP/M-based systems. Both provide a macro and conditional-assembly syntax and generate a Microsoft-compatible relocatable object file. Allowing for relocation of 8-bit expressions, each assembler includes a relocatable linking loader and a library manager. \$425 on 8-in. soft-sectored diskettes. **Systems Consultants Inc.**, 4015 Hancock St, San Diego, CA 92110. Phone (714) 222-6381. TWX 910-335-1660.

Circle No 254

CPU BOARD. Compatible with the IEEE-696 S-100 bus, the 16-bit Model C-86 operates at 5 MHz in standard configurations; an optional version runs at 8 MHz. The standard board features an 8086 µP, an on-board local bus that contains 2k×16 bits of PROM, an RS-232C serial I/O port, a software-programmable timer, and a special expansion connector that permits the addition of arithmetic and I/O processors. Because the S-100 bus permits as many as 16 bus masters to operate on a single bus, the unit includes a timing scheme that allows free transition from one bus master to another. The board also directly addresses 1M bytes of memory, switch selectable within the full 16M-byte space. Operating-system software and high-level languages are available. \$725 (5-MHz unit); \$825 (8-MHz unit). **Piiceon Inc.**, 2350 Bering Dr, San Jose, CA 95131. Phone (408) 946-8030. **Circle No 255**

Open For Business



Bring on your forms, any forms. Whether you need to print on bank checks or multipart reports, standard pages or outsize sheets, our alphanumeric DMTP-8 impact form printer has a 50 character/line capacity, edge guide sensor and three open sides to take your work flow as it comes. Everything fits. And with the exceptionally long needle stroke, every message is crisp and clear — even on multiple copies from .003" to .015" thick.

Work it hard. Work it long, even at high-volume POS jobs. With its heavy-duty construction and extra-long life dot matrix print head, the DMTP-8 is made to take it. Other advantages: programmable character pitch, and the long-haul economy of replaceable ink rollers and a self-reversing ribbon with a 10-million character life. And, of course, the price: just \$269 in 100's. Write or call now for details.

PRINTER. Model 85 features 7×7 and 14×7 dot-matrix printing, six character sizes, 100-cps bidirectional operation, selectable tractor or friction paper feed and ribbon-cartridge loading. It also provides variable-line-density and continuous-form-length controls. Telecommunication capabilities include baud rates to 9600, parallel and serial RS-232C-outputs, X-on/X-off transmission controls and a 1k-byte buffer. Furnishing a full 96-character ASCII set, the printer provides both upper- and lower-case printing at 80, 96 or 132 characters/line on a 8½-in.-wide paper. The paper feed runs at 10 ips. \$625 (100). **DIP Inc.**, 745 Atlantic Ave, Boston, MA 02111. Phone (617) 482-4214. **Circle No 256**



**PRACTICAL
AUTOMATION, INC.**

Trap Falls Road, Shelton, Conn. 06484/Tel: (203) 929-5381

For more information, Circle No 78



Sometimes inputs and outputs can be a little tricky.

That's why our new 12-bit multiplying doubled-buffered DAC has more pins instead of less—28 in fact, to give you I/O flexibility, to make data conversion less tricky.

The HS3120 accepts 4, 8, and even 12-bit bytes from the bus in one gulp, without keeping the processor waiting.

Double buffers allow the input and output to be updated independently. Outputs can be unipolar or bipolar, ± 10 or ± 5 volts.

Getting this all on a single, money-saving monolithic chip wasn't easy. But then neither is technical leadership in data conversion, and we're committed to that.

The HS3120 is only \$22.50 in 100s, even less if you want 12-bit resolution with reduced linearity. Call or write so we can give you the complete technical story.

Hybrid Systems

CORPORATION

Crosby Drive, Bedford, MA 01730. Tel. (617) 275-1570 (TWX 710-326-7584 HYBRIDSYS BFRD)

In Germany: Hybrid Systems GmbH, Luisenplatz 4, 6100 Darmstadt, Germany. Tel. (06151)-291595 (TELEX 419390 HYSY D)
In the United Kingdom: Hybrid (Component) Systems U.K. Ltd., 12A Park Street, Camberley, Surrey. Tel. (0276)28128 (TELEX 858720 HYBRID G)
In France: Hybrid Systems S.A.R.L. 14 Rue du Morvan SILIC 525, 94633 Rungis CEDEX, France. Tel. (1)-6878336 (TELEX 250969 HYSYS)

For more information, Circle No 79

Disc has made it easy for the OEM using optical encoders in small quantities to realize costs in the same low range as the big users—like under \$100.00.

We've maintained the same high order of resolution, accuracy, and reliability found in our more expensive units for this new EC series. "EC," obviously, is our economy model, but it could also stand for exceptional capabilities. Here's what you get for your \$99 (much less in quantity):

- LED source
- 20 to 1024 pulses / revolution
- Differential electronics
- Square wave output
- ± 2.5 minutes accuracy
- Solar cell light sensors
- Instrument bearings
- $\frac{1}{4}$ " shaft for interfacing

Translated into benefits, these features mean the Disc EC ROTASWITCH® Encoder gives you superior performance, a long service life, and a unit cost you just can't touch.

That's the model EC 81. It has a single channel output. If you need dual channel, we also offer the EC 82 at \$125.00 in single quantities. It too plummets to well under \$100.00 in quantity.

A new spec sheet is just off the press—write or call for your copy. Immediate questions can be answered by calling 714/979-5300.

Disc Instruments, Inc., 102 East Baker Street, Costa Mesa, CA 92626. TWX: (910) 595-1987
DISC CSMA



THE PRICE OF OPTICAL ENCODERS JUST PLUMMETED.



For more information, Circle No 80

New Products



CRT DISPLAY. Providing local mass storage with one or two flexible minidisk drives, Model 2642A display station has a dedicated data-file system, text-editing capabilities and a forms-design utility. It furnishes a built-in memory for 88 lines of 80 characters; eight user-definable screen-labeled soft keys to execute predetermined functions; display enhancements that include underline, half-bright, blink and inverse video in any combination; a large-character and math-character set and a line-drawing set. A 270k-byte double-sided, double-density, 5½-in. flexible minidisk drive for off-line text storage comes standard. With an optional second drive, total disk storage is 540k bytes. \$6750 (one minidisk drive); \$7750 (two drives); \$6250 for tape-cartridge-drive option. **Hewlett-Packard Co.**, 1507 Page Mill Rd, Palo Alto, CA 94304. Phone local office. **Circle No 257**

STATISTICAL MULTIPLEXER.

The SM/2A 2-channel unit allows two independent asynchronous terminals, such as a printer and a CRT, to communicate simultaneously over one dial-up or leased telephone line. Key features include error detection and automatic retransmission without manual intervention; compression of blank spaces in reports; separate, independent buffers for each terminal; and independent baud-rate selec-

"That's Incredible!!"



A triac driver/SSR rated to
0.5 amp/600 V in a 6-pin DIP.
Needs only 5 mA to operate.
Choice of zero crossing
or random turn-on.

The amazing new TOC-4000 and TOC-5000 triac drivers represent the most advanced solid-state power relays in the industry. They easily replace Motorola MOC3031 or MOC3011 drivers while offering significant increases in current voltage and sensitivity. Continuing evidence that Theta-J is the leading edge in SSR technology. As low as \$1.48 in 10K quantities! Theta-J Corporation, 208 West Cummings Park, Woburn, Massachusetts 01801. (617) 935-7600



Theta-J Corporation

For more information, Circle No 82

New Products

Now RCA CMOS bursts into color.

New video interface Microboard has all you need to design a custom terminal.

For the first time; a CMOS Microboard with:

- up to 128 user-programmable characters
- 8 programmable colors, or black and white display
- audio output for tones or white noise
- parallel input port for keyboard
- graphics and motion
- NTSC and PAL versions.

So you can:

- program graphs, charts, messages
- get any combination of sounds
- add a keyboard for human interaction

- use it with any RCA Microboard computer
- use our optional programming design aid, the VIS interpreter (CDP 18S835).

Plus, you get all the advantages of CMOS, making it ideal for industrial controls.

For more information on the CDP18S661, contact any RCA Solid State sales office or appointed distributor. Or contact RCA Solid State headquarters in Somerville, N.J. Brussels, Belgium. Hong Kong. Sao Paulo, Brazil.

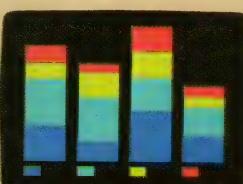
Or call Microsystems Marketing toll-free (800) 526-3862.



Alphanumeric.



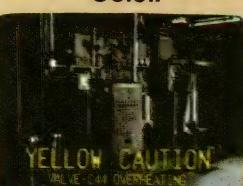
Color.



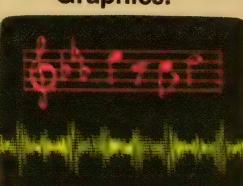
Graphics.



Special characters.



Overlay.



Programmed sound.

Another reason to switch to CMOS.

RCA

For more information, Circle No 83

tion. Compatible with RS-232 asynchronous serial devices, the SM/2A operates with full-duplex modem types, such as 103A (300 baud, dial-up), 212A (300/1200 baud, dial-up) and 202T (1200/1800 baud leased line). It supports data rates to 4800 baud for direct-connect or short-haul modems. \$825. Delivery, 30 to 60 days ARO. **Technical Analysis Corp**, 120 W Wieuca Rd Northeast, Atlanta, GA 30342. Phone (404) 252-1045. **Circle No 258**



CARTRIDGE SUBSYSTEM. An S-100-compatible 6400-bpi cartridge - tape unit for Winchester-disk backup. Tape Interchange Package (TIP) permits transfer of programs and data files from a Winchester disk to a 13.4M-byte tape cartridge. Linking to the drive under CP/M and MP/M operating systems, it provides a 2-min-per-megabyte backup/restore rate. Software in CP/M format resides on a single-sided, single-density 8-in. floppy disk. \$2100 for rack-mounting or \$2200 (25) for table-mounting DS-100 controller, cartridge drive and power supply. **Alloy Engineering Co Inc**, 85 Speen St, Framingham, MA 01701. Phone (617) 620-1710. TWX 710-380-7624. **Circle No 259**

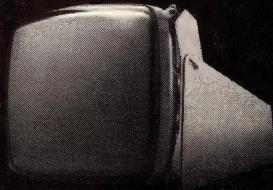
ASSEMBLERS. These assemblers convert Data General computers operating under DOS, MRDOS, RDOS or AOS into multiuser μ P development systems for 8086, 68000, Z8000 or TI 9900 16-bit μ Ps.

A video bandwidth of 30 MHz and a 1200-line resolution make this new CRT monitor the brightest and sharpest you can get.

C. Itoh's new model 1201BE in our QDM series is capable of receiving separate horizontal drive pulse, vertical drive pulse and video input at the TTL level. This separate signal mode eliminates composite sync and video signal processing. The CRT is equipped with its own power supply unit. P4 phosphor is standard, but optional P31 or P39 phosphors can be provided. Available options: Dynamic Focus, Skip Scan, a non-glare etched face and a 19.5 KHz horizontal frequency.

The high performance and low price offered with this new CRT monitor give you all you need to really outshine your system's competition. For complete information contact your nearest C. Itoh representative or C. Itoh Electronics, Inc., 5301 Beethoven Street, Los Angeles, CA 90066; Tel. (213) 390-7778; Telex: (WU) 65-2451; or 666 Third Avenue, New York, NY 10017; Tel (212) 682-0420; Telex: (WU) 12-5059.

C. ITOH ELECTRONICS, INC.



Introducing the 12" CRT monitor for the systems designer with bright ideas.



VICTOR... Number 1 in Impact Matrix Printing!



Model 5080

A Unique Printing Terminal

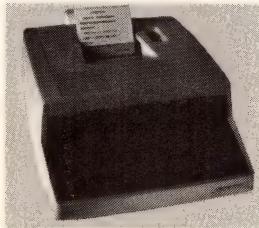
- 80 column, bi-directional printing
- Upper & lower case font
- Full graphics — 480 columns per line
- Top of form & horizontal tabs
- True 100 cps throughput
- Bi-directional friction and sprocket paper feed
- Large 360 character buffer
- Four interfaces — standard parallel & RS232 & TTY & **IEEE-488**
- Baud rate switch selectable
- Self-test
- UL/CSA approved
- Intelligent shortest path head return

The Model 5080, shown above, is a heavy-duty printing terminal offered for sale at most competitive prices. Only \$995 in single quantity! This printer has been designed to conform to the most stringent computer specifications, including software on/off control, status feedback signals and a busy signal should you fill our extra large buffer. Don't delay, order now to insure early delivery!

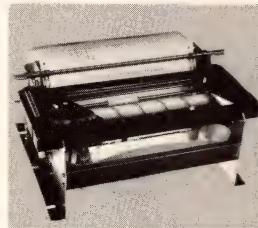
Victor has delivered more than 700,000 industrial, quality matrix printers. These are terminals, mechanisms, and heads designed to solve your problems. Products that are backed by a strong application engineering staff, worldwide service and 50 years of Victor pride in product.

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FRANCE — METROLOGIE, (1) 791 44 44 **SOUTH AFRICA** — EAGLE, 45-1421
SINGAPORE — OG, 917788 or 918592 **HONG KONG** — GILMAN, 3-427144

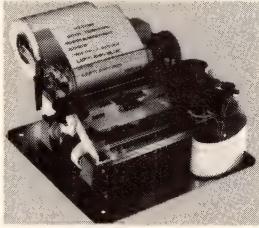
A Complete Line of Impact Matrix Printers



Model 5010



Model 80



Model 130



Model 129

VICTOR DATA PRODUCTS

Subsidiary of Walter Kidde & Company, Inc.

KIDDE

3900 North Rockwell Street, Chicago, Illinois 60618
Telephone: 312-539-8200

For more information, Circle No 85

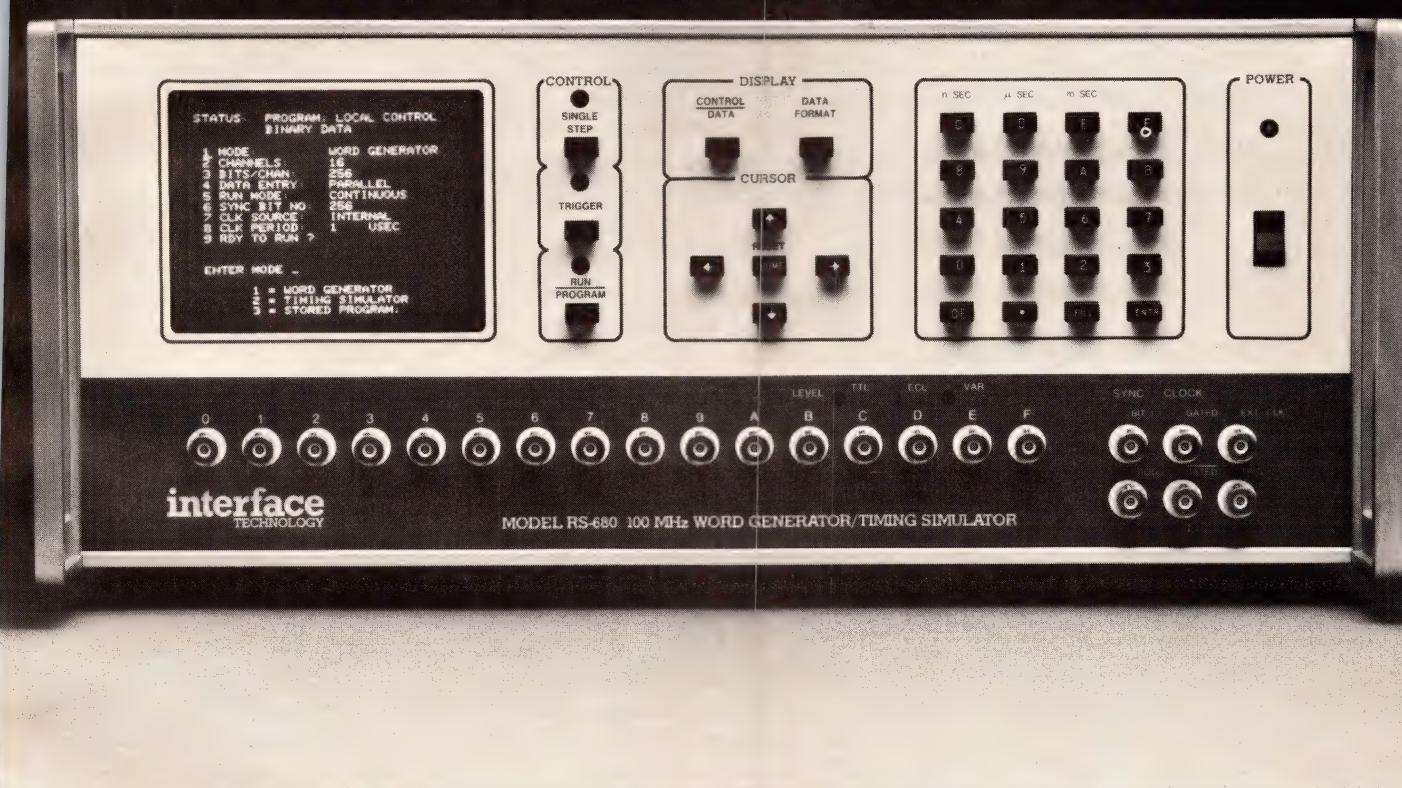
New Products

Operating-system commands as well as utilities remain unchanged. You can add other assemblers as required, creating a universal development system capable of supporting 30 μ Ps and as many as 128 users. Written in Data General assembly language, the assemblers feature high-speed operation, relocation capability, symbolic cross reference, macro definition and conditional assembly. From \$1200 (3). **Boston Systems Office Inc**, 469 Moody St, Waltham, MA 02154. Phone (617) 894-7800. TWX 710-324-0760. **Circle No 260**

PASCAL COMPILER. For use with the company's family of 32-bit minicomputers, this package provides shared access to as many as 64 users for the development and testing of PASCAL programs. Conforming to ANSI's draft language standards, the software offers extensions to support modular program development; separate compilation of PASCAL procedures; easy access to external library routines in PASCAL, FORTRAN or assembly languages; and access to executive-service routines for functions such as time of day, date, device assignments and file positioning. \$5250. **Perkin Elmer Corp**, 2 Crescent Pl, Oceanport, NJ 07757. Phone (201) 229-6800. **Circle No 261**

CMOS μ C. Multibus compatible, the single-board CBC 800 executes the Z80 instruction set and operates at 2.5 MHz with a 1.6- μ sec min execution time. Its 158 instructions provide software compatibility with Z80, 8085 and 8080 μ Ps. Features include 4k, 8k or 16k bytes of static CMOS RAM (running

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How do you get up to 256 states
on up to eight simultaneous chan-

nels with resolution as low as 10 ns for each state's period? Use the RS-680 as a timing simulator.

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without Wait states); sockets for up to 32k bytes of CMOS, NMOS or programmable ROM; two peripheral interface chips incorporating 44 programmable parallel-I/O lines; and four 16-bit programmable counter/timers. A UART furnishes serial RS-232 communication with software-programmable transmission rates to 9.6k baud. On-board logic allows 20 prioritized interrupts in three operating modes. Approximately \$1600 for 4k-byte commercial version. Delivery, starting in December/January. **Diversified Technology Inc**, Box 465, Ridgeland, MS 39157. Phone (601) 856-4121. TLX 585326. **Circle No 262**

TAPE SYSTEM. A digital data-storage unit that meets MIL-E-16400, -5400 and -4158 for industrial severe-environment, military and aerospace applications, SETS-1 consists of a compact drive module coupled to a sealed removable tape module. Storing 23M bits at 1600 bpi on 300 ft of 1/4-in. magnetic tape, it furnishes bidirectional read/write on four tracks with a 192k-bps transfer rate. The tape module is hermetically sealed to prevent environmental contamination, and the unit has an operating-temperature range of -40 to +71°C. \$7200 (OEM qty). **Electronic Memories and Magnetics Corp**, 20630 Plummer St, Chatsworth, CA 91311. Phone (213) 998-9090. **Circle No 263**

DATA-ENTRY SOFTWARE. This package for the company's Flexifile 21 floppy-disk subsystem provides prompted data entry for distributed-data-processing environments. Formatting data on an interactive

step-by-step basis and allowing computer operators to input information by responding to prompts displayed or printed by a terminal, it detects syntactical errors, generates corrective messages and features programmable fields and editing capabilities. \$200 on diskette for current users of the Flexifile 21. **Tri-Data**, 505 E Middlefield Rd, Mt View, CA 94043. Phone (415) 969-3700. TWX 910-379-6978. **Circle No 264**

DISK EMULATOR. For use with PDP-11 computers and for emulating DEC RF11-A systems (utilizing dynamic MOS memory as the storage medium in place of disk platters), Model PM-RF11 features 10 times the transfer rate and requires 1700 times less access time compared with RF11 systems. Including write-lock switches for memory protection and ECC circuitry, the unit comes in two basic configurations. PM-RF11A supplies 512k bytes of MOS memory in a 5.25-in. chassis. Extra slots accept two additional 512k-byte expansion kits, providing a maximum of 1.5M bytes. PM-RF11B furnishes 512k bytes of memory in a 10.5-in. chassis and accepts up to 4M bytes of dynamic MOS memory via the PM-RF11B backplane and expansion kits. \$9733 for basic PM-RF11A with 512k-byte memory. Delivery, 60 days ARO. **Plessey Peripheral Systems**, 17466 Daimler Ave, Irvine, CA 92714. Phone (714) 557-9811. TWX 910-595-1976. **Circle No 265**

M68000 SOFTWARE. Designed to run under the firm's HA-SP/68000 operating system in 32k-byte-RAM-configured systems, the RA68000ML resident

assembler and the LINK68000 linking loader (part of the assembler package) consist of a 2-pass macro assembler and a 1-pass linking loader. Providing full macro facilities and conditional assembly, the RA68000 produces a listing and a sorted symbol table, generates relocatable and linking object code, uses a hash-coded symbol table and binary search of the mnemonic table and allows separately assembled routines to share data and produce ROMable code. EDIT68000, a resident line-oriented context editor providing for the creation and editing of program and data files, contains an extensive set of editing and file-manipulation commands. \$350 for RA68000ML with LINK68000; \$150 for EDIT68000 including user manual and object code on floppy disk. **Hemenway Associates Inc**, 101 Tremont St, Boston, MA 02108. Phone (617) 426-1931. **Circle No 266**

TAPE SYSTEM. Available in 800-bpi NRZ, 1600-bpi PE and NRZ/PE dual-density configurations, this 75-ips unit comes with interfaces for Nova/Eclipse, PDP-11 and LSI-11 minicomputers. RS-232, IEEE-488 and dual-buffered I/O interfaces are also available. The PDP-11 interface requires one quad peripheral controller; the LSI-11 interface uses two dual slots. The Data General interface comes on a standard 15×15-in. board requiring one slot in its computer chassis. Automatic self test and off-line diagnostics are provided. \$6985 for 800-bpi NRZ; \$7485 for 1600-bpi PE; \$7885 for NRZ/PE dual density. **TDX Peripherals**, 150 New York Ave, Halesite, NY 11743. Phone (516) 423-3232. TWX 510-226-0449. **Circle No 267**

STR® technology for high data integrity. Three major tape formats for design flexibility.



We don't forget the OEM's needs.

The **STR-810** digital recorder is designed for data logging, data acquisition and as a system loader. Using either the 3M DC-300A or DC-300XL cartridges, packing density is 1600 bpi, for respective data capacities of 2.3M bytes and 3.4M bytes per cartridge, using four tracks. Features include microprocessor-controlled tape movement and read/write electronics. For maximum versatility, interfaces include RS-232 and IEEE-488. Or, using control and status lines available, you can interface to specific microcomputers such as LSI-11 and 8080. EPI's optional ANSI X3.56 formatter, with NRZI or phase-encoded personality cards, turns the 810 into a plug-in component for industrial instrumentation and mini/microcomputer-interfaced peripheral markets. Price: \$756 in quantities of 100. **STR-STREAM** is a high-speed, high-capacity version of the 810 designed for Winchester disc backup. Density is 6400 bpi for 17M bytes capacity per cartridge. Features include advanced head design, MFM formatting and compatibility with 8" or 14" discs.

Circle no. 101

EPI's **STR-610** is a compact, low cost digital recorder that's ideal for use with POS terminals, smart CRT terminals and as a general peripheral for mini/microcomputer-based systems. The 610's recording density is 800 bpi for a capacity of 168K bytes/track, using a two-track 3M DC-100 mini-cartridge. Formatting is ANSI Standard and interfacing is parallel, with a variety of options. Price: \$280 in quantities of 1,000. **The STR-LINK III** is a high-speed (9600 baud), portable program loader that uses the STR-610's drive system and shares the same specifications. It is used as a field service tool for diagnostic work or as a peripheral in a mini/microcomputer system. STR-LINK III uses a serial RS-232 interface for data communications or data terminal applications, and it can be controlled through RS-232, ASCII control codes, or manually. Price: \$1,615 in single quantity.

Circle no. 102

STR-LINK II is EPI's proven medium-speed (1200 baud) universal portable program loader for programmable controllers and process control systems. Using a standard cassette, it features switch-selectable transmission modes for maximum flexibility. Price: \$1,889 in single quantity.

For maximum design freedom, proven reliability and high data integrity through Speed Tolerant Recording technology, remember EPI—the company that doesn't forget the OEM's needs. For more information, contact Electronic Processors Inc., P.O. Box 569, Englewood, Colorado 80110. Phone (303) 761-8540.

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New Products

COMPONENTS & PACKAGING



DATA-CONVERTER KIT. An engineering sampler, this kit contains a variety of 8- and 10-bit A/D and D/A converters. It also includes a copy of the company's data-converter handbook (providing appropriate data sheets) along with various booklets and flyers dealing with applications such as μ P interfacing.

The kit contains 12 converters. The DAC complement includes two 8-bit ZN426E-8 units, two ZN428E-8 8-bit μ P-compatible devices with latched inputs and two ZN429E-8 8-bit designs.

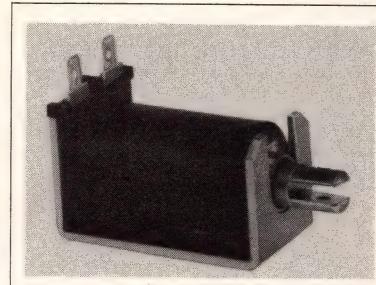
Four ADCs are offered: two ZN427E-8 8-bit units featuring 3-state outputs, one ZN432CJ-10 fast 10-bit unit and the ZN433CJ-10 10-bit monolithic tracking converter. Two dual 8-bit ZN425E-8 A/D-D/A devices complete the converter package.

All converters and literature come housed in a 3-ring binder. \$85. **Ferranti Electric Inc.**, 87 Modular Ave, Commack, NY 11725. Phone (516) 543-0200.

Circle No 170

ZIF CONNECTORS. Card-edge designs with accumulated compact 20-position modules, PB18 Series devices feature a sliding-cam stick that sequentially actuates individual contacts as

it is pushed through the unit. Regardless of the number of contacts employed, actuation force equals 4.4 lbs. The line includes both top- and side-entry designs. Housings are 15% GF PBT, and the phosphor-bronze contacts spec rated lifetime of 20,000 cycles. **ITT Cannon Electric**, 666 E Dyer Rd, Santa Ana, CA 92702. Phone (714)-557-4700. **Circle No 171**



C-FRAME SOLENOIDS. Compact general-purpose devices, Series S26 units feature an enclosed design that provides coil and terminal protection. The solenoids have pull-on-operate forces >48 oz and holding forces to 72 oz. Standard voltages for dc models equal 6, 12, 24, 110 and 220V; ac designs have 12, 24, 120 and 240V requirements. Maximum stroke equals 0.5 to 1 in. for intermittent dc and ac models, respectively. Coil power ratings range from 7W to 21 VA, depending on model. From \$1.82 (500). **Potter & Brumfield**, 200 Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-1000. **Circle No 172**

PRECISION TRIMMERS. Housed in a 3/4-in. package, Model 1280 26-turn devices spec setting accuracy of 0.05%. Standard resistance values (with $\pm 10\%$ tolerance) range from 10Ω to $20\text{ k}\Omega$. TCR specs at $\pm 15\text{ ppm}/^\circ\text{C}$ over -55 to $+125^\circ\text{C}$. Load-life stability measures

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TO-8 Package	TO-8 Package
3dB BW = 21 MHz	3dB $f_{c_0} = 450 \text{ MHz}$ (and $\approx 1500 \text{ MHz}$)
40dB BW = 5.5 MHz	$f_{c_0} = 400 \text{ MHz}$
Number of sections = 5	Number of sections = 5
IL = -4dB	IL = -0.6dB at 500 MHz
40dB/3dB shape factor = 2.6:1	3dB/40dB shape factor = 1.13:1

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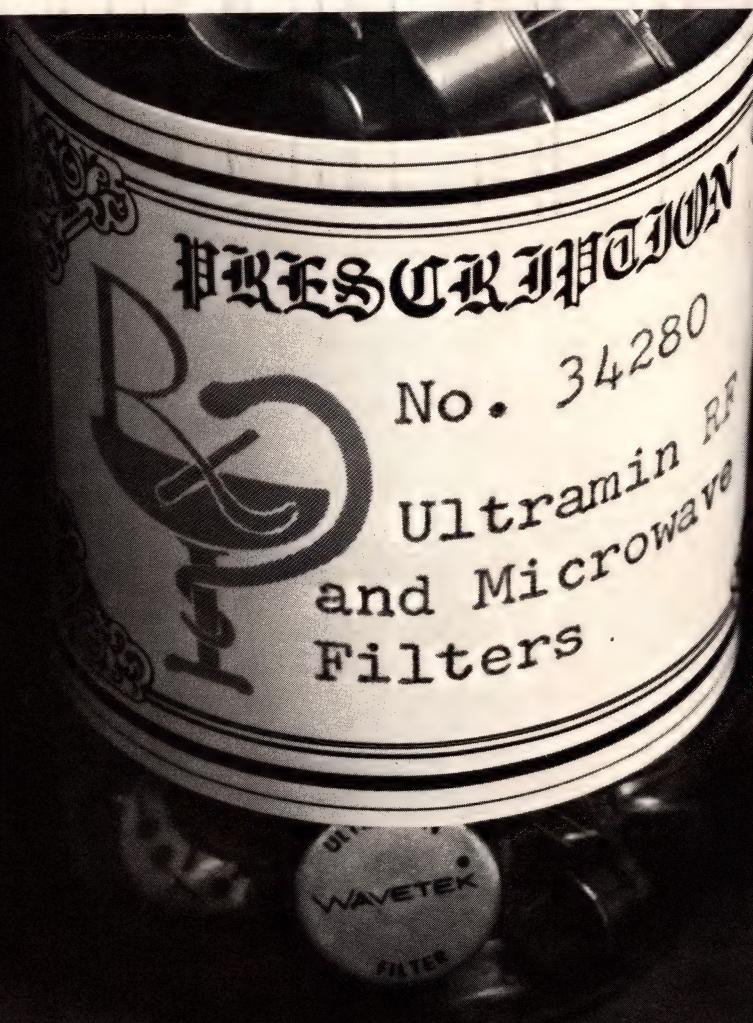
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1% Δ R max after 2000 hrs under full-rated power of 750 mW at 25°C. The precious metals in the units' multifinger wiper are alloyed for resistance to wear and conductivity. Torque compensation is provided for the wiper's rider block. \$2.92. (1000). Delivery, stock to 8 wks ARO. **Vishay Resistive Systems Group**, 62 Lincoln Hwy, Malvern, PA 19355. Phone (215) 644-1300. **Circle No 173**

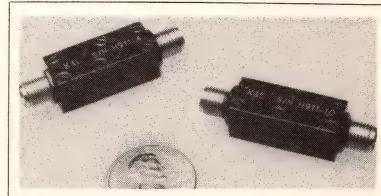
I/O BOARDS. Designed to facilitate the implementation of the company's Series 6 I/O modules, MS-H Series boards are available in 4-, 8-, 16- and 24-position configurations. Designed to fit standard relay racks, they feature 5A fuses to protect field wiring and loads, LED

status-indicator lights, decoupling capacitors and pads for optional mass-terminated ribbon-cable headers. They also provide sockets that can handle 10,000 insert/remove cycles, solder masks and connector compatibility with industry-standard single-board computers. \$22 to \$102. **Crydom Div/IRC**, 1521 E Grand Ave, El Segundo, CA 90245. Phone (213) 322-4986. **Circle No 174**

TEST SOCKETS. Offering 21 and 25 positions, respectively, TS-21 and SB-25B-G strip sockets are designed for burn-in test applications. The TS-21 features long contact springs to ease device insertion, while the SB-25-G's narrow profile (0.175 in. max) satisfies high-density

applications. Each unit can be cut to any length and is available with ratings of 150°C (beryllium-copper gold-plated contacts) or 200°C (beryllium-nickel gold-plated contacts). TS-21, \$1.88; SB-25B-G, \$1.09 (1000). **Robinson-Nugent Inc**, 800 E Eighth St, New Albany, IN 47150. Phone (812) 945-0211.

Circle No 175



BANDPASS FILTERS. A line of microminiature (0.14 in.³) evanescent TE-mode designs, Series FV devices cover 0.5 to 18 GHz. They employ two to 17

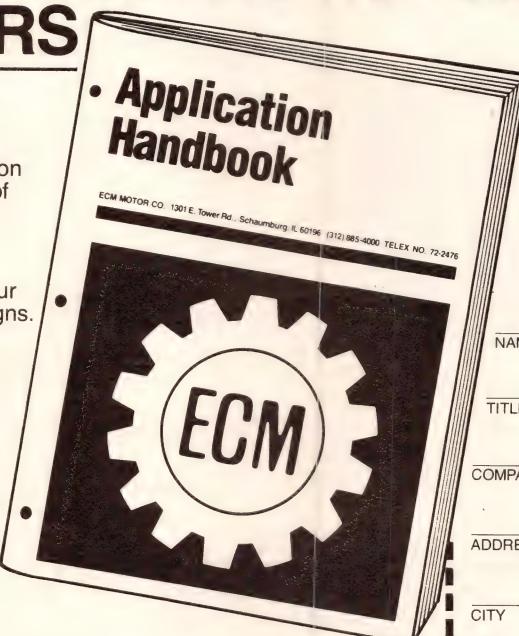
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resonant sections, and you can specify bandwidths from 4 to 70%. Standard RF terminals are SMA jack connectors; however, pins can be provided to permit microstrip-circuit mounting. From \$250. **K&L Microwave Inc.**, 408 Coles Circle, Salisbury, MD 21801. Phone (301) 749-2424. **Circle No 176**

CABLE SLEEVES. Insultite ITCSF flame-retardant heat-shrinkable units and ITCSN nonflame-retardant sleeves suit aerial, underground and URD direct-buried applications. Conforming to a wide range of connector and splice configurations, they offer shrink ratios as high as 4:1 and a choice of tubing sizes. Said to provide tight-fitting and water-resistant

fits without cracking or splitting, the thick-wall irradiated-cross-linked-polyolefin sleeves come with adhesive sealants or uncoated. Standard cut lengths range from 6 to 48 in. with custom lengths also available. **Electronized Chemicals Co.**, Burlington, MA 01803. Phone (617) 272-2850. **Circle No 177**

n-key or 2-key rollover, stepped-keycap arrangement, repeat-function optional keys for assignment to any available code and four function keys for assignment to any of the 90 positions in the encoder. **ITT Datanetics**, 10840 Talbert Ave, Fountain Valley, CA 92708. Phone (714) 549-1191. **Circle No 178**

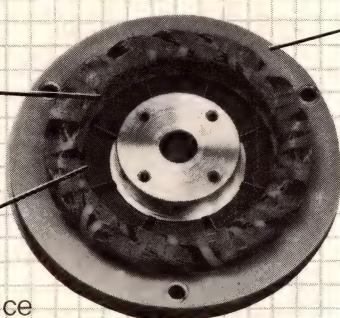


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DETECTOR/PREAMP. For fiber-optic data-communications systems, Model MFOD404F provides the functions of a photosensitive diode detector and a transimpedance amplifier on the same chip. With a responsivity of 30 mV/ μ W (at $V_{cc}=5V$), the unit sustains data rates to 10M baud/sec over medium distances, is compatible with the company's MFOE103F and -106F emitters and fits AMP-compatible metal fiber-optic connector barrels. \$37. **Motorola Semiconductor Products Inc.**, Box 20912, Phoenix, AZ 85036. Phone (602) 244-4556. **Circle No 180**

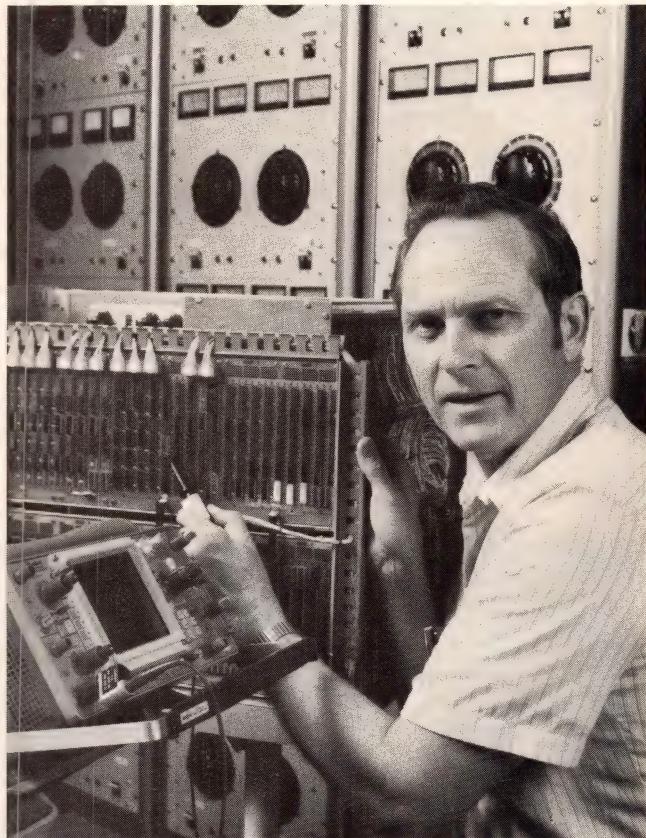
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Most people who are still using MOV's just haven't tried our TransZorb transient voltage suppressors yet. It's true that MOV's cost a little less than TransZorbs, but what kind of performance are you really getting? What is the response time when a transient does come along? Will the performance be the same after a few pulses, or does it deteriorate? What happens to its breakdown voltage over time? And, what happens to its clamping voltage when a pulse does occur? If it exceeds your maximum voltage ratings, your circuit is in trouble, and you're not getting the protection you need... at any price.

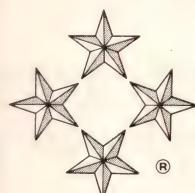
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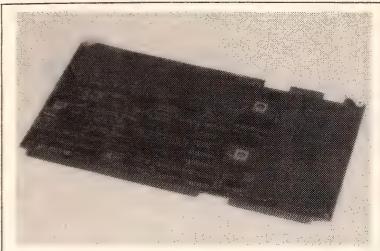
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New Products

COMPUTER-SYSTEM SUBASSEMBLIES



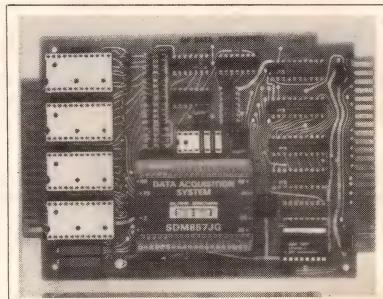
BOARD COMPUTER. Based on an 8086 CPU, the Custom 86 single-board computer conforms to the IEEE-P796 bus standard (Intel's Multibus). And because it provides two breadboarding areas, developing a product with it allows designed-from-scratch flexibility while maintaining the shorter design cycle possible with standard products.

You can use the breadboarding areas for additions

such as 128k of PROM, 64k of RAM, A/D and D/A converters, a high-speed I/O bus or battery-backed-up CMOS RAM. Connections for the μ C's control lines, chip-select lines for PROM and I/O, interrupt-control lines and some prototyping interconnections are brought out to the breadboarding areas.

Both the address and data lines come out fully buffered to wire-wrapping pins. From \$995.
Microbar Systems Inc, 1120 San Antonio Rd, Palo Alto, CA 94303. Phone (415) 964-2862.

A/D MODULE. Digitizing as many as eight separate differential analog inputs from such devices as pressure and temperature transducers for



instrumentation and data-acquisition applications, this 4.5×6.5-in. card features 12-bit resolution and gain variable from 2 to 1000. Conversion time specs at 25 µsec for low gains and up to 320 µsec for high gains. Sockets are provided for additional filtering, gain or attenuation. The device handles 4- to 20-mA signals. \$690. Delivery, 4 to 6 wks ARO.

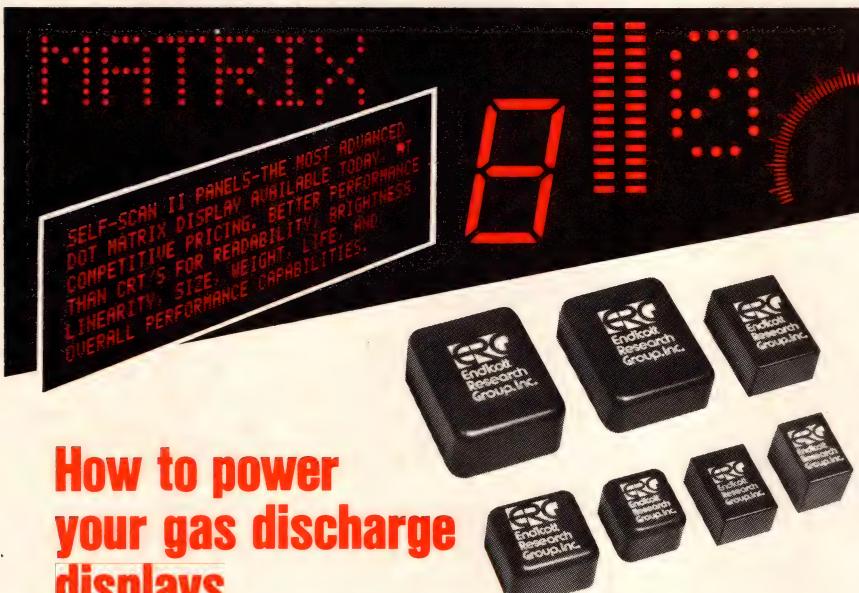
Giddings & Lewis Electronics,
666 S Military Rd, Fond du Lac,
WI 54935. Phone (414) 921-9400.

Circle No 210

COUNTER/TIMER CARD. An STD Bus unit providing three 16-bit counter/timer channels and six operating modes, the fully programmable multichannel Model 7309 features a crystal oscillator, a tapped clock divider, an 8-input multiplexer for each channel and programmable logic states at each clock, gate and output signal. Configured independently by the program, each channel provides event counting from dc to 2.5 MHz, marker and square-wave generation, time-interval measurements, one-shot simulation with hardware and software triggering, and retriggering and repetitive interrupt generation. Any channel can interrupt after the nth programmed event of loop

iteration. \$145 to \$195, depending on quantity. **Pro-Log Corp.**, 2411 Garden Rd, Monterey, CA 93940. Phone (408) 372-4593.

Circle No 211



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System 19/UniPak gives you design and purchasing freedom. This means you can select the best PROM for each application, and you can second-source for the best price and availability.

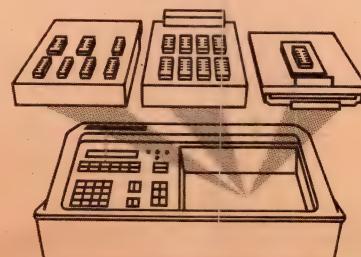
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UniPak has earned written approval from device manufacturers. And easy calibration lets you keep performance within PROM manufacturers' specifications.

UniPak algorithms shorten programming time enhancing System 19's use as a production tool. UniPak is the first module to use a newly developed algorithm which makes it possible to program a 64K EPROM in less than half the time it takes to program a 16K EPROM using standard methods.

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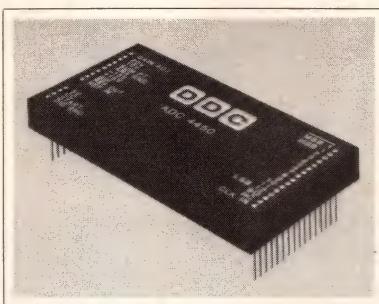
DATA I/O

New Products

TAPE CONTROLLER / FORMATTER. A fully embedded dual-density device, Model 1521 furnishes complete compatibility with DEC's TU10/TM11 tape subsystems. It works with LSI-11, -11/2 and -11/23 μCs and with industry-standard reel-to-reel transports that operate to 75 ips. You can switch-select recording in NRZ format at 200 to 800 bpi or in PE format at 1600 bpi. Self-test and subsystem diagnostics are included in firmware. \$2025 (25). **Datum Inc**, 1363 S State College Blvd, Anaheim, CA 92806. Phone (714) 533-6333.

Circle No 212

A/D CONVERTER. Featuring -72-dB total harmonic distortion and -72-dB intermodulation distortion, this unit runs from either an external (Model



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ANALOG-INPUT BOARD. BLC-8715 contains an 8085 CPU with 1k bytes of RAM, a 64k-byte address space and sockets for up to 4k bytes of user-programmable ROM/PROM. The unit also features an RS-232 serial interface, 22 programmable digital I/O channels and 16 single-ended and eight differential channels, software configurable in any mix or sequence. Analog inputs can be sampled at rates up to 25 kHz; the board can also perform digital processing and storage. BLC-8915 firmware permits rudimentary programming and debugging. A complete source-object listing is included in the firmware manual. \$1120 (100). **National Semiconductor**, 2900 Semiconductor Dr, Santa Clara, CA 95051. Phone (408) 737-5000. TWX 910-339-9240. **Circle No 214**

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with the **Re-Cirk-It** protector. Or nuisance tripping caused by normal starting surges. A white band signals when it's tripped, with reset as easy as pushing a button. No bothersome fuses to replace.

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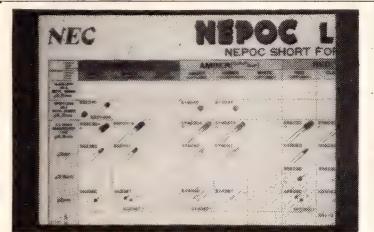
7273A

Literature



Selection considerations for reed switches

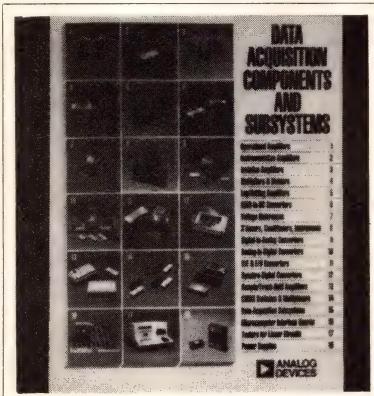
Dimensional drawings accompany specs for a line of reed switches in an 8-pg catalog. Included is data on dry-reed switches in miniature Form A, standard-size and miniature Form C configurations and on miniature Form A and Form C mercury-wetted devices. A stocking-range chart provides data on pull-in sensitivities available for standard, selected or tightened ampere-turn tolerances. The guide explains terms pertinent to reed-switch use, including "voltage hold-off" and "actuate time," and also provides a cross-reference/application-guide chart. **Hamlin Inc.**, Lake and Grove Sts, Lake Mills, WI 53551. **Circle No 215**



Handy reference highlights LED lamps

A full-color wall chart features a line of green, amber, red and IR LED lamps. Illustrations of components accompany data on device shapes, mechanical dimensions and ordering information. The reverse side

provides specs for photocoupler and photointerrupter devices, detailing external dimensions, pin connectors and applications; and photosensors, outlining metal-header, molded and ceramic-header types. **NEC Electron Inc.**, 3120 Central Expressway, Santa Clara, CA 95051. **Circle No 216**



Assortment of control and measurement devices

The 1000-pg "Data-Acquisition Components and Subsystems Catalog" contains product data sheets and tutorial sections and includes information for more than 500 standard data-conversion products, op amps, linear test systems, signal-conditioning products, computational circuits, subsystems for measurement and control and power supplies. Including a list of the firm's technical publications, it provides specs and application information for a line of products ranging from monolithic ICs to complete system-level products. **Analog Devices**, Box 280, Norwood, MA 02062. **Circle No 217**

Using a magnetic-tape controller

A 2-pg illustrated data sheet describes the TC-131, a single-

board dual-density magnetic-tape controller for use with the DEC PDP-11 computer family. It details the unit's performance range, highlighting features such as the unit's 33-word data buffer, which allows the controller to be placed anywhere on a Unibus without consideration for bus priorities, and the ability to read and write on the fly. **Western Peripherals Div of Wesper-corp**, 14321 Myford Rd, Tustin, CA 92680. **Circle No 218**



Data on line of UPS systems

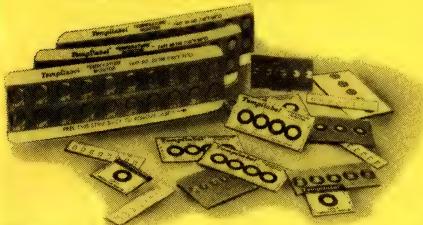
Data sheets highlight features and options for a line of uninterruptible - power - source systems rated from 25 to 150 kVA and include specs for units that utilize a reserve battery bank for standby emergency power. They also detail standard panel metering, which includes an input voltmeter and ammeter; a battery voltmeter and ammeter; and an output/bypass voltmeter, ammeter and frequency meter. Each 2-pg sheet details operating specs, including input and output voltages, static and dynamic regulation figures, overload and short-circuit limits and operating-temperature range. **Sola Electric**, 1717 Busse Rd, Elk Grove Village, IL 60007. **Circle No 219**

EDN PRODUCT MART

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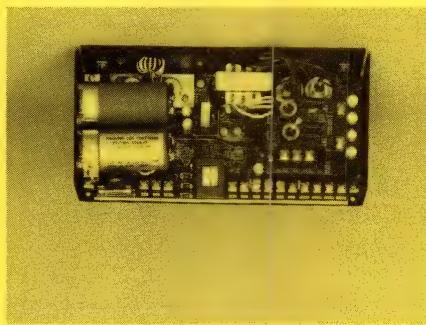
The center spot on a Tempilabel® Temperature Monitor turns black when the surface to which it is affixed reaches the specified temperature for that label. Reliable Tempilabel® monitors are available with single spots or with multiple spots with pre-determined increments of ratings for monitoring safe operating temperatures. Tempilabels® are self-adhesive and may be removed and attached to reports for permanent records. Temperature ranges: 100°F (33°C) to 600°F (316°C). 1% accuracy guaranteed. Monitors with 1, 4, 6 or 8 ratings on each with various increments. Priced as low as 10¢ each. Write or call for free sample. Circle number below for catalog & prices.

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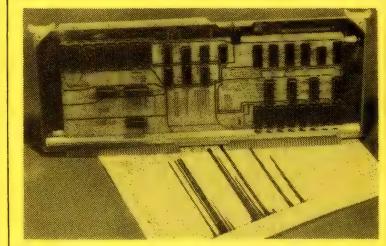
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New line of 200 watt triple output switching power supplies is already UL recognized. A triple output model 20E5/±12, delivers 5V at 30 amps and ±12 or ±15V at 1 amp. All units are available from stock. Features include a dual AC input 100-132/200-260VAC, line and load regulation of 0.2% and 0.3% respectively overvoltage protection, and 16ms crossover. Size is 4.92" X 10.5" X 2.25". Prices start at \$240. For applications assistance and Data Sheets call (213) 707-0120. NORTEL, 31149 Via Colinas—Bldg. 608, Westlake Village, CA 91361.

For more information, Circle No 131



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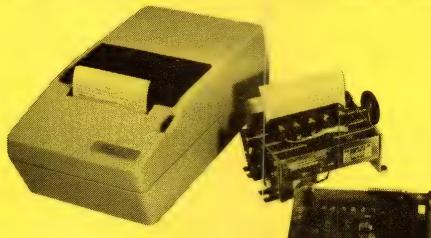
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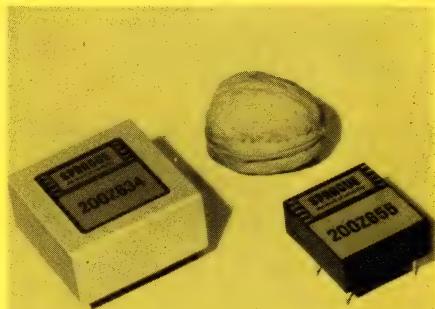
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For more information, Circle No 133



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We stock all the analog I/O our customers need, and we deliver it quickly.

Some of our boards are unique. Many are technically better than their "equivalents" and less expensive to boot.

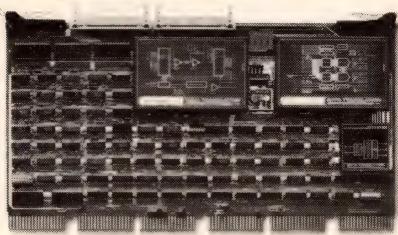
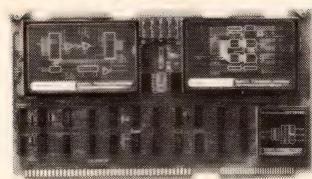
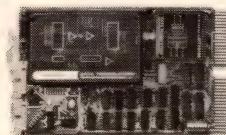
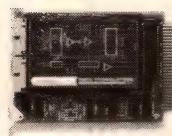
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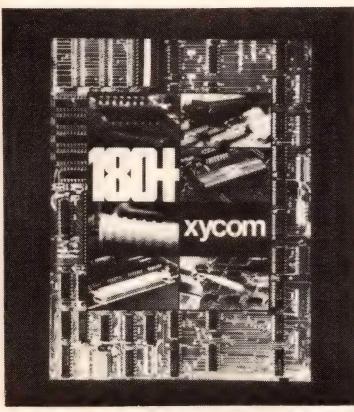
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For more information, Circle No 96

Literature



Data on modules and controllers

A 6-pg brochure describes the 180+ line of CPU, memory and I/O modules and controllers designed and manufactured for use in harsh industrial environments. According to the brochure, the series features increased mechanical and electrical integrity and greater tolerance of temperature, humidity, vibration and contaminants than its predecessors. Specs for product performance and testing are included. **Xycom**, Box 984, Ann Arbor, MI 48106.

Circle No 220

Detailed specs for coaxial connectors

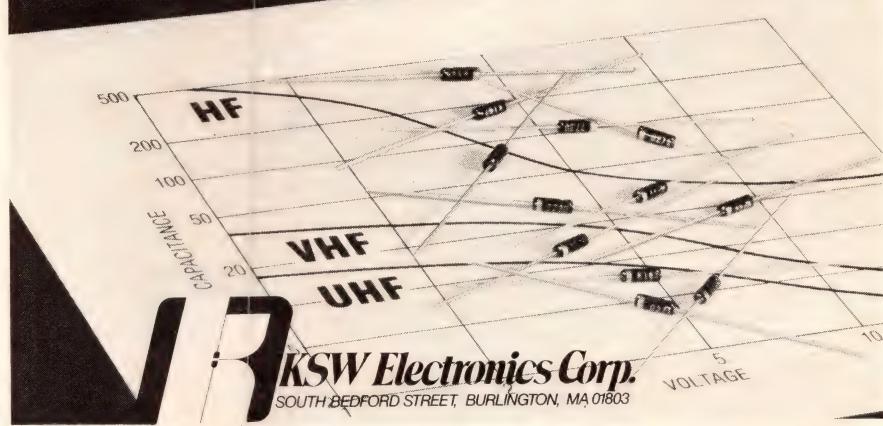
A 16-pg catalog details 250 standard BNC coaxial devices and illustrates four lines of clamping field-serviceable units (improved and standard Wedge-lock, Wedge-eze and improved V groove) and three lines of crimping devices (improved Econo-crimps, X units and Econo-crimps). It describes connectors qualified to MIL-C-39012 as well as pc-board, isolated-ground and RF terminations. **Automatic Connector Inc.**, 400 Moreland Rd, Commack, NY 11725.

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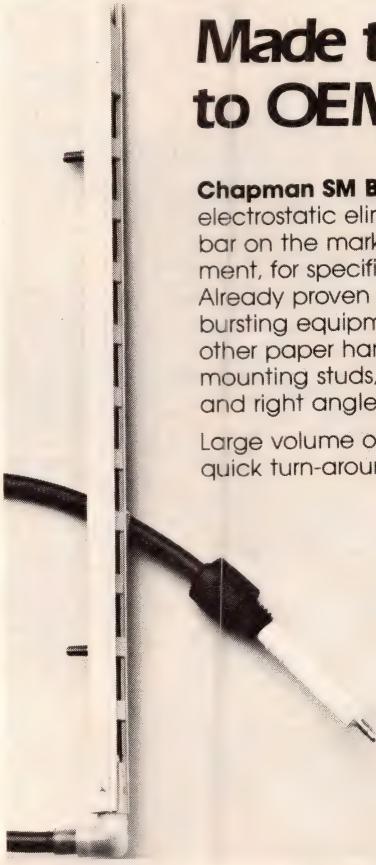


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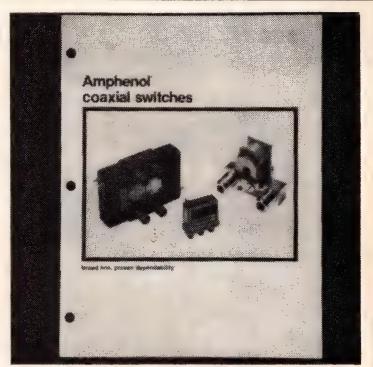
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TRICON INDUSTRIES, INC.
2325 Wisconsin Avenue
Downers Grove, IL 60515
Phone: (312) 964-2330

For more information, Circle No 98



Literature



Characteristics of coaxial switches

A 20-pg illustrated catalog details a coaxial-switch line that covers the 0 to 18-GHz range with rotary, bladed and Dynaform-type units in a variety of configurations. A functional selection chart summarizes the products. Switches are grouped by frequency ranges and further categorized by function, size and general characteristics. Specs and line drawings, circuit/schematics and ordering information complete the brochure.

Amphenol North America Div,
2122 York Rd, Oak Brook, IL
60521. **Circle No 222**

Track down quartz-crystal companies

The "1980 Quartz Crystal Industry Guide and Directory" contains listings of manufacturers in that field and includes names of management personnel as well as data on number of employees, size of facility and products manufactured. Listings are cross referenced by product category (eg, chemicals), chief executive and plant location. A bibliography concludes the 65-pg book. \$35 (plus \$1.95 postage and handling) for annual subscription, which includes 6-month updates. **GSM Inc**, Box 10121, Ft Lauderdale, FL 33334. **INQUIRE DIRECT**

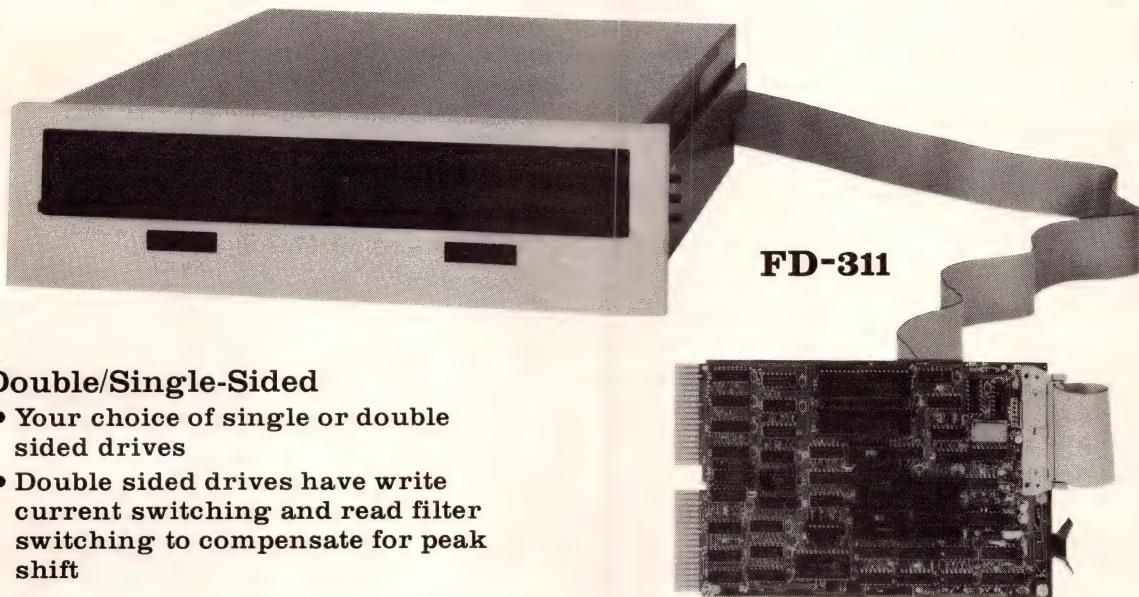
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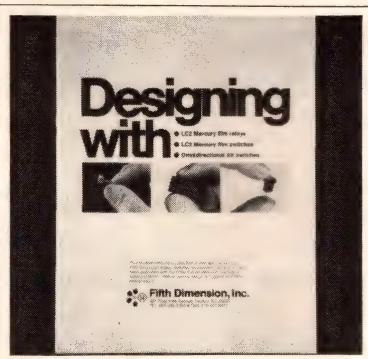
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A 12-pg booklet describes applications for mercury-film relays and switches and mercury-actuated tilt switches. It includes specs for nominal coil voltage, coil resistance, operating and release times and vibration and shock resistance. Illustrations accompany the application examples. **Fifth Dimension Inc**, 801 New York Ave, Trenton, NJ 08638.

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A 96-pg catalog describes technical and "how to" books available on topics such as energy, computers, robotics, electronics hobbies, electronic music, test equipment and servicing and engineering reference. A text summary and prices for hardbound and paperback copies accompany each entry. **TAB Books Inc**, Blue Ridge Summit, PA 17214.

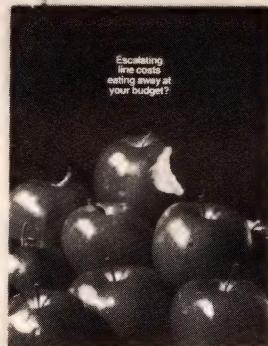
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Capabilities of a statistical multiplexer

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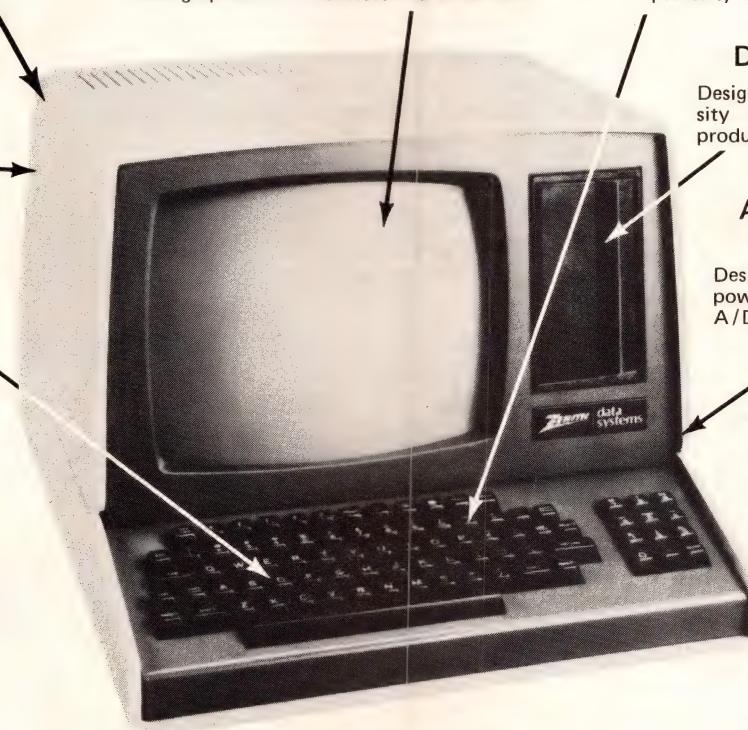
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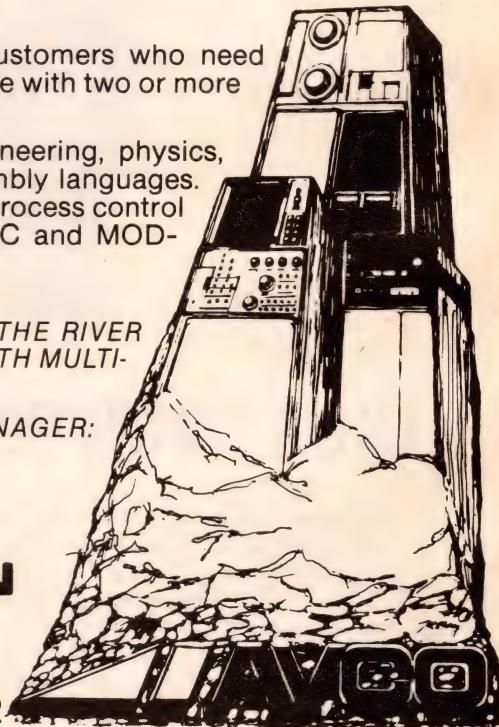
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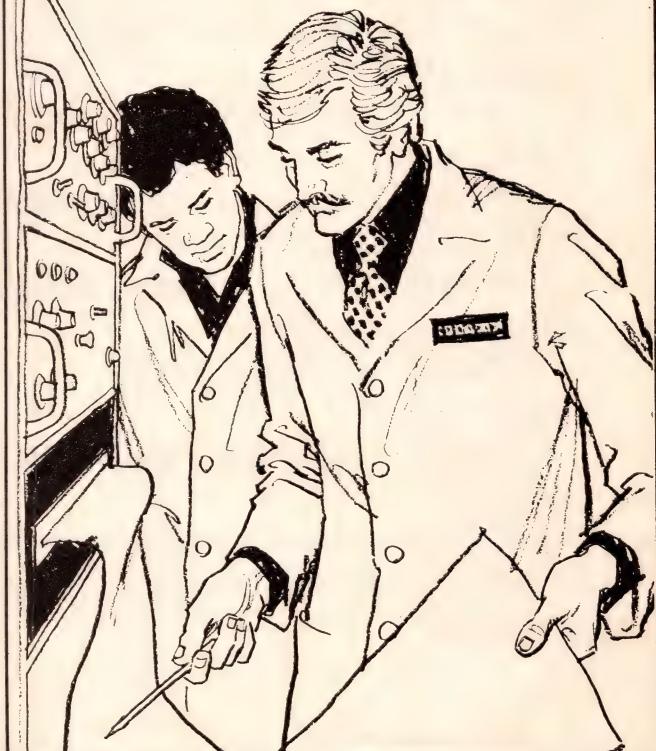
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Looking Ahead: Trends and Forecasts

\$9.6B 1984 market seen for 2-way business comm

The market for 2-way business communications—defined as including any electronic communications system that “provides a possibility for conversation”—will increase nearly fivefold over the first half of this decade to cumulatively total more than \$90 billion through 1985. This market growth encompasses a \$1.8 billion 1980 equipment market expanding to \$8 billion in 1984 (constant 1979 dollars), and services will add another \$2 billion to that year's revenue totals, forecasts Frost & Sullivan Inc, New York City.

One of the five business-communications market sectors considered, electronic mail will climb from a meager \$59 million in revenues last year to \$1.5 billion in 1985; the largest revenue share will go to common carriers and suppliers of switching services. And today's fledgling video-conference-service market will soar to \$500 million by 1985.

Other market developments include:

- Telephone interconnect—Private automatic branch exchanges (PABXs) now average about 85 lines and cost \$950 per line. But prices should decline during the forecast period because of technical advances, competitive pressure and amortization of initial investments.

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INTELLIGENT TYPEWRITERS	114	2500
FACSIMILE		
GROUPS 1-3	327	745
ULTRAFAST	—	40

SOURCE: FROST & SULLIVAN INC

Additionally, smart telephones that handle graphics data should become a major revenue source for interconnect suppliers, according to Frost & Sullivan.

- Telephone answering—“The novel notion of using a machine to answer corporate telephones,” comments Frost & Sullivan, “will be legitimatized by a forthcoming IBM product.”

Electronic Yellow Pages to bill \$2.5B by 1990

Product and service information of the type found in the telephone-book Yellow Pages will soon appear in electronic form. US operators of such services will derive revenues greater than \$200 million by 1985 and more than \$2.5 billion by 1990, according to International Resource Development Inc, Norwalk, CT.

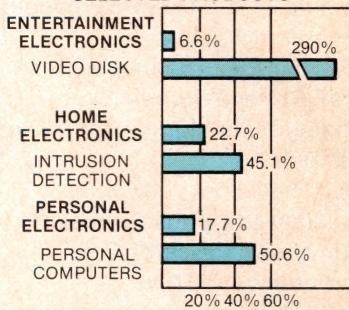
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Japan, US will continue consumer-electronics war

In the 1980s, the greatest Japanese challenge to US electronics manufacturers will not come from vigorous competition in the radio, TV and hi-fi fields as it did in the '60s and '70s. Instead, Japan will focus on other fast-growing entertainment-, home- and personal-electronic-product areas, according to Venture Development Corp (VDC).

Entertainment electronics, the largest of these product sectors, will see the most

ANNUAL GROWTH RATES FOR CONSUMER-ELECTRONICS CATEGORIES AND SELECTED PRODUCTS



SOURCE: Venture Development Corp

intense competition, particularly in the video arena. The struggle among the currently incompatible video-disk systems could easily become the battle of the decade, according to the Wellesley, MA market-research firm.

Competition among US and Japanese firms should be less intense in the home-electronics area, however. The market for electronic intrusion-detection equipment, for example, is still at an early stage of growth: US manufacturers such as General Electric still must work to build up the market. With an expected growth of 45% annually, though, this product area could prove rewarding to companies willing to educate consumers about their products' advantages.

Japanese companies are also maintaining a low profile in retail telephone equipment, says VDC. Despite annual growth exceeding 20% in some categories, Japan is largely leaving this area to US manufacturers.

Material for this page developed from *Electronic Business* magazine and other sources by Joan Morrow, Assistant Editor, and Jesse Victor, Assistant/New Products Editor.

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